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Includes: aerodynamics of channels, cowls, ducts, ejectors, nozzles, etc.

For related information see: 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 11 Fluid Mechanics.

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For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 33 Stresses and Loads.

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VOLUME 1 NUMBER 16

Scientific and Technical Aerospace Reports

A Semimonthly Publication of the National Aeronautics and Space Administration

August 23, 1963

01 GENERAL

Includes: management; space law and legal matters; symposia or conferences of a broad or a general nature.

N63-17503 National Aeronautics and Space Administration, Washington, D.C.
ADMINISTRATION AND MANAGEMENT OF SPACE EXPLORATION
James E. Webb [1962] 16 p Based on an address presented at the Natl. Conf. of the Am. Soc. for Public Admin., Detroit, Mich.
GPO: $0.10

The administration and management of NASA's space exploration program is discussed. Five characteristics distinguishing the administration's assignment are: (1) the multiple and interrelated objectives of space research and exploration, both peaceful and military; (2) the wide variety of skills and vast accumulation of facilities and equipment used by space research and exploration; (3) the complexity of the task of organizing the human effort for space exploration, because of long lead times coupled with a rapidly evolving technology; (4) the necessity of a high degree of reliability; and (5) the persistent scrutiny of the public, the Congress, and the scientific community of the space research and exploration program. The challenge to administration presented by such a program is seen to consist of: finding ways of maintaining an imaginative, inquisitive, and open mind within the program; obtaining a better and broader understanding of the civilian space program; obtaining and retaining qualified scientific and engineering personnel within the program; and maintaining good relations between NASA and its subcontractors. D.E.R.

N63-17522 Polytechnic Inst. of Brooklyn. Microwave Research Inst., N.Y.
A SURVEY OF CURRENT RESEARCH AT THE MICROWAVE RESEARCH INSTITUTE Progress Report No. 23, 1 Oct. 1962 through 31 Mar. 1963
Walter K. Kahn et al [1963] 140 p refs
(Grant AF-AFOSR-62-295)
(R-452.23-63)

A summary of research activities is reported in the following six areas: (1) electromagnetics; (2) plasma electrophysics and electronics; (3) solid-state and material research; (4) microwave circuits; (5) network theory; and (6) systems and control. N.E.A.

N63-17596 Aeronautical Research Inst. of Sweden, Stockholm
SPEED AND SAFETY IN CIVIL AVIATION. PART I: SPEED
Bo Lundberg [1962] 109 p 42 refs The Third Daniel and Florence Guggenheim Memorial Lecture Presented at the Third Intern. Cong. of the Aeron. Sci. (ICAS III), Stockholm, Aug. 27-31, 1962
(FFA-94)

The real need for supersonic commercial aviation is investigated in terms of the actual reduction of travel time and the economics of aircraft operation at speeds greater than the present near-sonic speeds. At distance ranges below 1,000 miles, tremendous civil aviation markets are opening up for V/STOL aircraft with low noise properties and increased subsonic cruising speeds; these aircraft will have access to airports situated close to urban centers, thus reducing ground-time losses. The economics of supersonic transport (SST) on ranges above 1000 miles is related to both increased competition within aviation itself and to passenger appeal. With regard to passenger appeal, the study concludes that a very small percentage will fly SST on ranges from 1,000 to 2,000 miles; and that less than half of the passengers will prefer SST on ranges from 2,000 to 5,000 miles at equal availability and equal average fares. Static and dynamic analyses of the impact of SST on commercial aviation indicate that, to maintain the economic equilibrium, the SST must from the start display considerably lower actual operating cost than that of contemporary subsonic long-range aircraft in order to compensate for the anticipated more rapid developments in subsonic technology. This study concludes that concentration on subsonic improvements in all range markets would promote civil aviation far more than the introduction of supersonic commercial aviation. M.P.G.

N63-17620 Massachusetts Inst. of Tech. Center for Materials Science and Engineering, Cambridge
RESEARCH IN MATERIALS SCIENCE AND ENGINEERING Annual Report, 1962-1963
R. A. Smith Apr. 1963 379 p refs
(NASA Contract NAS9-153; Contracts AT(30-1)-956; AF 04 (647)-303; Nonr-1841(10); DA-ARO(D)31-124-G49; ARPA-SD-90; NIH Grant A-2262(CA); NSF Grant 6071 et al)

The areas covered by this annual report include the following: chemical and solid-state physics; electric, magnetic, and optical properties of materials and applications to devices; metallurgy and materials science; materials engineering; and the research efforts of the National Magnet, Instrumentation, and Lincoln Laboratories. R.C.M.

N63-17631 Lincoln Lab., Mass. Inst. of Tech., Lexington
SOVIET BOOKS ON RADIOTECHNOLOGY AND ELECTRONICS IN 1962 13th Reference Bibliography
G. S. Lantsberg Sept. 4, 1962 46 p 197 refs Transl. from Radiotekh. i Elektron. (Moscow) v. 7, no. 4, 1962 p 723-744
(Contract AF 19(628)-500)

N63-17715 Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio
A SELECTED BIBLIOGRAPHY OF PULSED RADIATION EFFECTS

W. H. Veazie and S. F. Collier, comps. June 1, 1963 32 p 261 refs
(Contract AF 33(657)-10085)
(REIC Memo. 24)

N63-17759 National Aeronautics and Space Administration, Washington, D.C.
THE NASA'S SPACE RESEARCH PROGRAM News Release
Milton B. Ames, Jr. Presented at Tenth Rass. Intern. Elettronica Nucleare e Teleradiocinematografica Third Intern. Tech.-Sci. Meeting on Space, Rome, Italy, June 28, 1963 60 p
Available from NASA. Office of Scientific and Technical Information, Wash., D.C.

A review of the content and objectives of the space program of the United States and its impact on science and technology is given. The policy of the United States activities in space is devoted to peaceful research and exploration carried out by the National Aeronautics and Space Administration. A description of NASA program activities is given in the following areas: (1) space science; (2) applications of space technology into all phases of economy; (3) manned spaceflight; (4) advanced research and technology to provide technological bases for present and future aeronautics and space activities; and (5) tracking and data acquisition. N.E.A.

N63-17812 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
CAN THE ANTARCTIC TREATY POINT TO A TREATY IN OUTER SPACE
Richard P. Schuster, Jr. N.Y., AIAA [1963] 34 p Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963
(AIAA Paper 63-285) AIAA: $0.50 members, $1.00 nonmembers

Each article of the Antarctic Treaty is considered briefly in an attempt to identify those provisions which appear to support or point towards an outer-space treaty and to determine which provisions suggest additional consideration. The principles concerning scientific cooperation and freedom of scientific investigation appear to be the most nearly transferrable to an outer-space treaty without essential change. Matters of sovereignty and geographical demarcation should be relatively negotiable because the issues involved would probably lend themselves to discrete expression. National security considerations are anticipated to identify the areas where transition from the Antarctic Treaty to an outer-space treaty will be most difficult, both because of the difficulties of defining military–nonmilitary distinctions and because the inspection of outer-space activities includes the observation of related activities on earth. Matters such as ratification, amendment, and dispute resolution are also expected to provide serious difficulties because of their military threat implications. Before an outer-space treaty can even be negotiated, the effect of the existence of nonsignatories, if any, and the effect of the treaty on the parties to the treaty may have to be resolved. However, the fact that an international treaty such as the Antarctic Treaty exists and effectively restricts military activities, allows unlimited observation and inspection, and provides for scientific cooperation is considered to be a genuine milestone, regardless of its admitted shortcomings. M.P.G.

N63-17999 Battelle Memorial Inst., Columbus, Ohio
PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING APRIL, 1963
Russell W. Dayton and Ronald F. Dickerson May 1, 1963 84 p
(Contract W-7405-eng-92)
(BMI-1630) OTS: $2.00

The progress of programs designed to convert nuclear power for civilian applications is reported. Included are papers on: reactor materials and components, fuel studies, fuel-element development, radioisotope and radiation applications, development of a tracer system for in-place filter evaluation, materials evaluation, and coated particle fuel materials. D.E.R.

N63-18034 American Academy of Arts and Sciences, Boston, Mass.
AN ANALYSIS AND SUMMARY OF RESPONSES FROM FELLOWS OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES CONCERNING THE SPACE PROGRAM AS A SUBJECT FOR STUDY AND THOUGHT
Geno Ballotti, comp. [1962] 16 p
(NASA Grant NsG-253-62)
(NASA CR-50306) OTS: $1.60 ph, $0.80 mf

Responses to questions on a wide range of problems in the following areas are presented: (1) NASA's goals; (2) NASA's cost; (3) the manpower problem; (4) NASA's effect on basic research and pure science; (5) NASA's effect on the university and the teaching profession and the relationship between NASA and the universities; (6) the problems of liberal curricula and NASA's effect on the humanities; (7) the impact of technical innovations on society and culture in general; (8) the economic impact of the space program; (9) NASA's administrative problems; (10) the public acceptance of NASA's program; and (11) the historical analogies to the current exploration of space. I.v.L.

N63-18066 National Research Council of Canada, Ottawa
QUARTERLY BULLETIN OF THE DIVISION OF MECHANICAL ENGINEERING AND THE NATIONAL AERONAUTICAL ESTABLISHMENT, 1 JANUARY TO 31 MARCH 1963
[1963] 117 p 146 refs
(DME/NAE 1963 (1))

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3. CURRENT PROJECTS OF THE DIVISION OF MECHANICAL ENGINEERING AND THE NATIONAL AERONAUTICAL ESTABLISHMENT p 56–117 76 refs (See N63-18069 16-01)

N63-18069 National Research Council of Canada, Ottawa
CURRENT PROJECTS OF THE DIVISION OF MECHANICAL ENGINEERING AND THE NATIONAL AERONAUTICAL ESTABLISHMENT
In its Quarterly Bull. of the Div. of Mech. Eng. and the Natl. Aeron. Estab., 1 Jan. to 31 Mar. 1963 p 56–117 76 refs (See N63-18066 16-01)

The current status of the many varied projects of the mechanical engineering and aeronautical engineering divisions of the National Research Council of Canada are reported. Programs include: the mechanics of metallic and nonmetallic substances and structures; computer studies; biological engineering; hydrodynamics research; aerodynamic studies of VTOL aircraft, wind tunnels, and the North Star research aircraft; and thermodynamics research. D.E.R.

02 AERODYNAMICS OF BODIES, COMBINATIONS, AND INTERNAL FLOW

Includes: aerodynamics of channels, cowls, ducts, ejectors, nozzles, etc.

For related information see: 03 Aerodynamics of Wings, Rotors and Control Surfaces; and 11 Fluid Mechanics.

N63-17523 Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS AT M = 1.41 ON A THIN, CONICALLY-CAMBERED ELLIPTIC CONE OF 30° SEMI-VERTEX ANGLE
E. W. E. Rogers, V. G. Quincey, and J. Callinan (NPL) London, HMSO, 1963 28 p 5 refs
(ARC-R&M-3306; previously issued as ARC-23329) Available from HMSO: 11s

Pressure-plotting and strain-gage balance tests have been made at a Mach number of 1.41 on a conically cambered cone of 30° semivertex angle, and with a ratio of the major to the minor axis of its cross section equal to 11 · 55. The camber line was designed for a C_L of 0.3. The upper-surface pressure distribution was found to be strongly influenced by the boundary-layer state in the leading-edge region, and when this was turbulent, good agreement with the theoretical spanwise loading was obtained at the design C_L, though this was obtained at a somewhat higher incidence than the design value. The flow development with incidence for both boundary-layer states is discussed with the aid of oil-flow patterns. The results for the cambered cone are compared with those obtained in 1954 for a corresponding uncambered elliptic cone. Both cones have the same normal-force curve slope; the cambered cone has a higher minimum drag coefficient, but a smaller lift-dependent drag factor. At the design C_L the drag of the two models is the same. Author

N63-17545 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
TRANSONIC INVESTIGATION OF THE STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF LOW-ASPECT-RATIO WING-BODY CONFIGURATIONS AT ANGLES OF ATTACK FROM 0° TO 90°
Charles D. Trescot, Jr., Lawrence E. Putnam, and Cuyler W. Brooks, Jr. Washington, NASA, June 1963 37 p 5 refs
(NASA TN D-1947) OTS: $1.00

An investigation has been conducted in the Langley transonic blowdown tunnel to determine the effects of wing planform and other geometric parameters on the static longitudinal aerodynamic characteristics of winged vehicles suitable for reentry. Wing leading-edge radius and wing lower surface contour were also varied for several of the configurations during the investigation. The tests were made at Mach numbers of about 0.8, 1.01, and 1.18 for angles-of-attack that generally varied from about −4° to 91°. The results of the investigation indicate that, at a given test Mach number, planform variation for the basic models had a considerable effect on lift-curve slope at an angle-of-attack of 0° but had essentially no effect on maximum lift coefficient, lift-curve slope at an angle-of-attack of 90°, or maximum drag coefficient. The values of maximum lift-drag ratio for the circle model varied between 2.5 and 3.0 whereas those of the other basic planforms generally varied between 3 and 4. The basic planforms were longitudinally unstable below the angle-of-attack at which maximum lift was obtained and longitudinally stable above this angle-of-attack, the moment reference point being located at the centroid of planform area of each planform. Changing the leading edge of the 65° triangular model from cylindrical to square caused higher maximum drag and, generally, small positive increments in pitching moment through the test angle-of-attack range. Contouring the wing lower surface of the basic ellipse model to form the model designated as ellipse (convex) caused positive increments in pitching moment, decreases in lift coefficient and maximum drag coefficient, and small changes in stability. Contouring the wing lower surface of the 75° model to form a trihedron model caused large negative increments in pitching-moment coefficient, an increase in lift coefficient below and a decrease in lift coefficient above an angle-of-attack of 20°, and an increase in drag coefficient below an angle-of-attack of about 50°. The trihedron model had the lowest maximum lift-drag ratio of the configurations tested. Author

N63-17557 Toronto U. Inst. of Aerophysics (Canada)
ASYMMETRY OF ANNULAR JET FLOW IN GROUND PROXIMITY. PART II – A STATIC 60° INWARDLY INCLINED ANNULAR JET AT AN ANGLE OF ATTACK
Paul R. Stephens Oct. 1962 120 p 9 refs
(UTIA-TN-63)

The simplest of theories presented by other researchers has been moderately expanded to include nonzero angles-of-attack of a static nozzle. The resulting curves have been employed for comparisons with some of the experimental results. In conjunction with the theoretical development, some rather extensive experimentation was conducted. This was to encompass a cross section of the possible combinations of the four effective parameters—height, jet pressure ratio, jet thickness, and angle-of-attack. Flow patterns on the ground board and in the nozzle plane of flow symmetry were photographed. The total force normal to the nozzle base and the pressure distributions of the nozzle base and on the ground board were measured simultaneously. All of the phenomena associated with an annular flow at zero angle-of-attack persist through changes in that parameter. In fact, all the measured quantities depend as much on angle-of-attack as on height above ground. Author

N63-17592 Army Missile Command. Directorate of Research and Development, Redstone Arsenal, Ala.
THE STATIC STABILITY CHARACTERISTICS OF SEVERAL CONE-CYLINDER-FLARE-CYLINDER CONFIGURATIONS AT MACH NUMBERS 0.4 TO 4.5
D. J. Spring June 3, 1963 278 p 3 refs
(RF-TR-63-14)

The aerodynamic characteristics of various cone-cylinder-flare-skirt configurations were investigated between Mach Numbers 0.4 to 4.5. The Reynolds-number range for the tests was from 0.5 to 6.0 million per foot. Data are presented in basic form, along with cross plots, to show the effect of changing various body-component shapes. Author

N63-17616 Deutsche Versuchsanstalt für Luft- und Raumfahrt. Inst. für Angewandte Gasdynamik, Aachen (W. Germany)
A COMPREHENSIVE DEMONSTRATION OF PRESSURE DISTRIBUTION CALCULATIONS FOR A SYMMETRICAL ROTATING FLYING BODY WITH AXISYMMETRIC SUPERSONIC AND SUBSONIC FLOW BY EMPLOYING THE APPROXIMATION METHOD FOR LINEAR COMPRESSIBILITY INFLOW [ZUSAMMENFASSENDE DARSTELLUNG DER BERECHNUNG DER DRUCKVERTEILUNG AN ROTATIONSSYMETRISCHEN FLUGKORPERN BEI ACHSENSYMMETRISCHER ÜBERSCHALL- UND UNTERSCHALLSTRÖMUNG NACH NÄHERUNGSMETHODEN FÜR LINEARE KOMPRESSIBILITÄTSEINFLUSSE]
F. Keune Apr. 1963 86 p 19 refs In GERMAN
(DVL-278)

The flow on the surface is calculated for rotating bodies whose contour form in longitudinal section over the entire depth of the body is either assumed by means of a single analytical function or can be sufficiently accurately approximated. These calculations are applied to supersonic flight. The advantage of the approximation method lies primarily in the step-by-step improvement of the accuracy of the results for body ratio and the Mach number of the incident flow. The first step of "The Theory of Flow around Slender Bodies" applies to very slender bodies (or for the case of near sonic flow). However, the theory is expanded by two steps to consider thicker body forms and the influence of the Mach number according to the "linearized theory" in the case of high supersonic flow. These two new steps provide the desired information as to the accuracy of the results of the approximation method. I.v.L.

N63-17802 Aerojet-General Corp., Azusa, Calif.

SCALE MODEL TESTING OF 90° TURN EJECTOR SYSTEMS FOR ROCKET ENGINE ALTITUDE SIMULATION

R. E. Nelson, G. O. Patmor, B. L. Mc Farland, and B. Mandell N.Y., AIAA [1963] 10 p 6 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963
(Contracts AT(29-2)-1060 and AEC-NASA Contract SNP-1)
(AIAA Paper 63-174) AIAA: $0.50 members, $1.00 nonmembers

It has been shown that ejectors having a 90° bend and contoured nozzles start at higher nozzle-chamber pressures than do straight ejectors with conical nozzles. The chamber pressure required for starting was decreased as the overall length was increased, for a given A_{D1}/A^*, for the range tested ($L/D \leq 17.4$). Another factor influencing starting chamber pressure was the L/D of the straight section preceding the 90° turn. When short turning radii were used, ($R = 2D$) a straight section before the 90° turn of 3.3D resulted in the minimum starting pressure. As the turning radius is increased, the straight section prior to the turn can be decreased without affecting performance until at an ($R = 7.88D$) the straight section can be omitted with no adverse effects on performance. The effect upon performance of increasing the ejector turning radius from an $R = 2D$ to $R = 7.88D$ was the elimination of the hysteresis effect between the ejector starting point and the minimum operating point. With the hysteresis removed, about a 10% increase in performance was realized. The main influence of turning radii was found to be its effect on heat transfer. By increasing the turning radius from $2D_2$ to $7.88D_2$ the maximum heat transfer in the ejector was reduced by a factor of 5. With the use of a secondary ejector it is possible to develop an ejector system that will enable a 40:1 area ratio nozzle to flow full at an engine chamber pressure as low as 100 psia. To do this, however, an increase in ejector area aft of the secondary ejector is necessary to prevent choking of the primary fluid by the secondary fluid (working fluid of secondary ejector) and, of course, the secondary fluid must have a sufficient velocity to impart its momentum to the primary stream. Author

N63-17816 Glasgow U. (Gt. Brit.)

INTRODUCTORY SURVEY

W. J. Duncan *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Elasticity. Part IV: Experimental Methods [1960] p 5–59 42 refs (See N63-17815 16-33)

Aeroelasticity, which is concerned with the motion of deformable bodies through fluids, has now reached the state of maturity where a general and theoretical review can be made. This review includes the dynamical variables and equations of motion, representations of the structure and of the aerodynamic forces, methods for solving the dynamical equations, stability and stability criteria, classification of aeroelastic phenomena, divergence, reversal of control, flutter, influence of aeroelasticity on general stability, control and response, impulsive loading, buffeting and noise, kinetic heating, experimental methods and the use of models, practical aspects of aeroelasticity, and the early history of aeroelasticity. M.P.G.

N63-17906 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EFFECTS OF MASS ADDITION ON THE STABILITY OF SLENDER CONES AT HYPERSONIC SPEEDS

Clarence A. Syvertson and John B. Mc Devitt Repr. from AIAA J., 1963 1 p

The effects of mass addition (the injection of a foreign gas) on the flow over slender bodies are investigated. Helium was injected through holes in the hemispherical tip of a cone at angles of attack up to 14°, Mach numbers of 21, and Reynolds numbers to 4.5×10^6. The results show that the mass addition decreases the stability of the cone at low angles of attack and increases it at intermediate angles. A crossover occurs, and, at higher angles, the pitching moments are increased compared to the moments for the body without injection. The normal force decreases with addition at all angles of attack. The same body with a series of oversized spheres at the tip was tested, and it was found that by increasing sphere size, the same effect is noted; and the contribution of the sphere drag on the normal forces and pitching moments corresponds to a drag coefficient of 1. An hypothesis is given to explain the separation-like phenomena, stating that the injection creates a thick layer of low-energy gas encasing the cone, which behaves like a separated region and which cannot support the pressure variations when the cone is inclined and collects on the lee side of the cone at higher angles. D.E.R.

N63-17946 Polytechnic Inst. of Brooklyn, N.Y.

HIGH SPEED LOW DENSITY FLOW NEAR THE STAGNATION POINT OF A BLUNT BODY [Interim Report]

Reuben Ru-Ren Chow Wright-Patterson AFB, Ohio, Aeronautical Research Labs., May 1963 58 p 20 refs
(Contract AF 33(616)-7661)
(ARL-63-75)

In the present analysis the leading order shock conditions are obtained from the systematic order of magnitude analysis. A complete matching scheme for the components of heat flux and stresses between the shock and the boundary layer is proposed for the study of the flow field as well as the surface heat transfer to the body. No postulation, except the axial symmetry, has been made concerning the shape of the shock. The shape of the matching surface can be obtained uniquely from the present analysis. A method of solution has been introduced so that the laborious job of numerical integration of the flow equations with complicated boundary conditions can be bypassed. The governing equations are transformed and reduced to algebraic forms with the knowledge of the usual similarity solutions of the boundary-layer equations. Calculation has been performed for the specific case of $M_\infty = 5.7$ and T_0 = the free-stream stagnation temperature = 2100° R. The heat-transfer result at the stagnation point is in good agreement with the experimental value, and shows a slight improvement to Cheng's Thin Shock Layer Theory in the range of application of the present schemes. The density and the stagnation enthalpy at the matching point are obtained as functions of the Reynolds number. They both show the appropriate asymptotic values of a discontinuous shock as the Reynolds number increases. The matching distance and the shock eccentricity are also obtained as functions of the Reynolds number. Author

N63-17988 National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

WIND-TUNNEL INVESTIGATION AT MACH NUMBERS FROM 0.50 TO 1.14 OF THE STATIC AERODYNAMIC CHARACTERISTICS OF A MODEL OF A PROJECT MERCURY CAPSULE

Albin O. Pearson Washington, NASA, July 1960 29 p 6 refs
(NASA TM X-292) OTS: $2.60 ph, $1.07 mf (Declassified)

The pitching-moment, normal-force, and axial-force characteristics of exit, reentry, and escape configurations of a 1/7-scale model of a Project Mercury capsule were investigated in the Langley 8-foot transonic pressure tunnel. The tests were conducted at angles-of-attack from approximately −2° to 85° for the exit and reentry configurations and from about −2° to 20° for the escape configuration. The Reynolds number varied from about 2.43×10^6 to 3.69×10^6. The results show that all the model configurations trimmed at angles-of-attack near 0°, and that the exit configuration was statically unstable; whereas the reentry and escape configurations had positive static stability. The addition of the tower and escape rocket to the exit configuration had a negligible effect on the slope of the normal-force coefficient but increased the axial-force coefficients. Author

N63-17989 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
WIND-TUNNEL INVESTIGATION OF THE STATIC AND DYNAMIC-ROTARY STABILITY DERIVATIVES OF A FLAT-TOP WING-BODY MODEL AT MACH NUMBERS OF 2.5, 3.0, AND 3.5
Bedford A. Lampkin and Kenneth C. Endicott Washington, NASA, Apr. 1960 42 p 9 refs
(NASA TM X-361) OTS: $4.60 ph, $1.46 mf (Declassified)

The results of a wind-tunnel investigation of the static and dynamic-rotary stability derivatives for a flat-top wing-body model are presented. The test was conducted at Mach numbers of 2.5, 3.0, and 3.5, and a Reynolds number of 5 million. The angle-of-attack range was approximately −16° to +12° at 0° sideslip. Also, static data were obtained through the angle-of-attack range at a constant 5° angle-of-sideslip and within an angle-of-sideslip range of −10° to +6° at a constant angle-of-attack of 6°. The model consisted of an arrow wing with tips drooped along a line inclined 3° to the model plane of symmetry, and a 3/4-power ogive half body mounted beneath the wing. A ventral fin was located at the rear of the half body. It was found that the model was directionally unstable at positive angles-of-attack above 5°; however, the dynamic damping was stabilizing about the three body axes throughout the test range. With either elevon or rudder deflection there were pronounced cross-coupling effects on the lateral and directional stability of the aircraft which make proper roll control difficult to attain. Elementary methods of estimating the derivatives were only moderately successful. Author

N63-17990 National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.
WIND-TUNNEL INVESTIGATION OF STATIC AERODYNAMIC CHARACTERISTICS OF A 1/9-SCALE MODEL OF A PROJECT MERCURY CAPSULE AT MACH NUMBERS FROM 1.60 TO 4.65
David S. Shaw and Kenneth L. Turner Washington, NASA, July 1960 27 p 6 refs
(NASA TM X-291) OTS: $2.60 ph, $1.01 mf (Declassified)

An investigation has been conducted in the Langley Unitary Plan wind tunnel to determine the static aerodynamic characteristics of a 1/9-scale model of a Project Mercury capsule at Mach numbers from 1.60 to 4.65. The results show that the escape configuration trims with positive stability near an angle-of-attack of 0° for all test Mach numbers. The pitching-moment curves near an angle-of-attack of 0° are nonlinear however, and unstable characteristics are definitely shown at high angles-of-attack. The exit configuration trims with negative stability near an angle-of-attack of 0° at Mach numbers from 1.60 to 3.94. At a Mach number of 4.65, however, the capsule exhibits stable characteristics. The reentry configuration trims with positive stability near an angle-of-attack of 0° for all test Mach numbers. Author

N63-18045 National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio
PERFORMANCE OF AN ALL-INTERNAL CONICAL COMPRESSION INLET WITH ANNULAR THROAT BLEED AT MACH NUMBER 5.0
Leonard E. Stitt and Leonard J. Obery Washington, NACA, Aug. 6, 1958 19 p 2 refs
(NACA RM E58E14) OTS: $1.60 ph, $0.80 mf (Declassified)

An all-internal conical compression inlet with annular bleed at the throat was investigated at Mach 5.0 and zero angle-of-attack. The minimum contraction ratio of the supersonic diffuser, coincident with a mass-flow ratio of 1.0, was determined to be 0.084, as compared with the isentropic contraction ratio of 0.04 at Mach 5.0. The overall inlet performance was very sensitive to the amount of annular bleed at the throat because of the extensive boundary layer. For example, the critical recovery varied from 41 percent with 6-percent bleed, to 59 percent with 25-percent bleed. Decreasing the spacing between the supersonic and subsonic diffusers increased the critical mass-flow ratio but reduced the range of subcritical mass-flow regulation. A constant-area section was required ahead of the subsonic diffuser in order to obtain reasonable performance. An inlet-engine net-thrust analysis indicated that the optimum performance occurred with from 20- to 25-percent bleed, depending on how the bypassed air was handled. Author

N63-18102 Iowa Inst. of Hydraulic Research, Iowa City
DRAG COEFFICIENTS OF SUPERCAVITATING BODIES OF REVOLUTION AT VARIOUS ANGLES OF YAW
Matilde Macagno and Tsu-Ying Hsieh Mar. 1963 27 p 11 refs
(Contract Nonr-1509(05))

Drag coefficients of bodies of revolution with hemispherical, 2-caliber ogival, 45° conical, and 2:1 ellipsoidal heads in supercavitating flows at various angles of yaw were investigated. Results indicate that: (1) The drag coefficients computed from the Iowa pressure data are higher than the values from other sources. (2) A linear relationship between the drag coefficient and cavity pressure was confirmed for all the head forms, even at relatively high cavitation numbers. The slope of each straight line varied slightly. (3) Only a slight change in the drag coefficient was found when the body was subjected to angles of yaw of 6° and 15° in supercavitating flows. I.v.L.

N63-18118 Avco-Everett Research Lab., Everett, Mass.
TRANSITION STRUCTURE IN THE HYPERSONIC SPHERE WAKE AS SHOWN BY THE SODIUM SCHLIEREN
W. K. Washburn and A. Goldburg Apr. 1963 9 p 6 refs
(Contracts AF 04(694)-33 and DA-19-020-ORD-5476; Proj. Defender)
(BSD-TDR-63-78; AMP-111)

A composite set of sodium schlieren photographs are presented of a nonsteady hypersonic sphere wake, at a pressure close to the onset of transition: d = 0.56 cm, p = 1.7 cm Hg. The enhanced index of refraction obtained with light operating near the resonant transition of the sodium vapor allows the observation of the classical development of turbulence in the hypersonic wake. Small amplitude disturbances of wave-like character are seen to originate near the body. These grow in the linear and nonlinear amplification regime into a nearly ordered vortex flow with characteristic frequencies. Subsequently, the large-scale flow fills up with instabilities, and decays towards small-scale fully developed turbulence. A comparison is made with the results of ordinary schlieren systems. Author

N63-18163 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TRAILBLAZER I REENTRY-BODY WING-TUNNEL TESTS AT A MACH NUMBER OF 6.7 WITH THEORETICAL AERODYNAMICS AND A LIMITED DYNAMICS ANALYSIS

Herbert R. Schippell Washington, NASA, July 1963 25 p 6 refs

(NASA TN D-1936) OTS: $0.75

The aerodynamic forces and moments of scale models of a Trailblazer I reentry configuration were experimentally determined in the Langley 11-inch hypersonic wind tunnel, at a Mach number of 6.7 in air. The reentry configuration is basically a 5-inch-diameter sphere with an aft-mounted short cylindrical appendage of less diameter than the sphere. The data obtained from the tests compare favorably with predictions made by a modified Newtonian theory, and the tests show that the configuration is statically unstable up to an angle-of-attack of about 30°, and becomes statically stable near an angle-of-attack of 90°. A limited theoretical analysis of the reentry body motions, using the measured data, shows that the aerodynamic moments interact with the body gyroscopic moments, and result in maximum angles-of-attack at maximum dynamic pressures. Author

N63-18192 Aerospace Corp. Aerodynamics and Propulsion Research Lab., El Segundo, Calif.

AN INVERSE METHOD FOR THE DETERMINATION OF THE THREE-DIMENSIONAL SUBSONIC FLOW REGION ABOUT BLUNTED BODIES WITHOUT AXIAL SYMMETRY AT SUPERSONIC FREE STREAM MACH NUMBERS

C. R. Ortloff June 3, 1963 66 p 14 refs

(Contract AF 04(695)-169)

(TDR-169(3230-11)TR-2; SSD-TDR-63-119)

A three-dimensional blunt-body inverse technique is formulated in terms of two-component stream functions in the spirit of the Ferri, Vaglio–Laurin axisymmetric blunt-body method. In a similar manner to the axisymmetric case, transformations are found that reduce the elliptic asymmetric shock layer to a transformed space in which shock, streamlines (or the intersections of stream surfaces), body, and sonic surface are *a priori* known, so that numerical analysis procedures are considerably simplified. Provided three equations in the three velocity components of the transformed space are numerically solved, then inverse transformations are given so that the corresponding velocities, pressure, and density at a point in the physical space may be determined. The class of given shocks considered represents portions of prolate ellipsoids in the physical space. Author

03 AERODYNAMICS OF WINGS, ROTORS, AND CONTROL SURFACES

Includes: ailerons; airfoil sections; cascades; fans; flaps; propellers; rotors; slats; spoilers; etc.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 11 Fluid Mechanics.

N63-17578 Aircraft Research Assn., Ltd., Bedford (Gt. Brit.)

MEASUREMENTS OF ZERO-LIFT DRAG AT SUPERSONIC SPEEDS FOR A SYMMETRICAL SLENDER WING MODEL WITH DIFFERENT ROUGHNESS BANDS

E. C. Carter May 1963 25 p 6 refs

(ARA-Wind Tunnel Note 48)

This note gives the results of tests in the A.R.A. 30-in. × 27-in. Supersonic Tunnel on a slender ogee wing (p = 0.45) to determine the drag at zero lift for the model fitted with various alternative roughness bands. Tests were made at Mach numbers from M = 1.6 to M = 2.4 over a wide range of Reynolds Number from about $R = 2.5 \times 10^6$ to $R = 7 \times 10^6$, based on the wing root chord of 2 ft. The results show that to fix transition at the higher Reynolds Numbers in this range, it may only be necessary to apply a roughness band over part of the span. If the band is kept to the minimum length that is essential and to the minimum practicable width (say, about 0.04-in.) and if the roughness is applied as sparsely as possible, it is probable that the roughness drag increment may only be about 0.0001 to 0.00015 in C_D. On the other hand, full-span bands 0.125-in. wide can typically give an increment of 0.0006 to 0.0008. Within reasonable limits, however, the roughness drag increment does not appear to be particularly sensitive to the height of the roughness provided this is sufficient to fix transition. The present results suggest that over the part of the wing where it is necessary to apply a roughness band, transition should occur fairly close to the band provided the roughness height Reynolds Number, R_k, exceeds the values that range from about 1000 at M = 1.6 to 1800 at M = 2.4. To ensure that the boundary layer was fully turbulent everywhere, however, particularly with a relatively sparse band and particularly at the higher Mach numbers, these values of R_k have to be increased by a factor which can be as high as 30% or more. Author

N63-17600 Toronto U. Inst. of Aerophysics (Canada)

PERFORMANCE AND OPERATION OF QUASI TWO-DIMENSIONAL JET FLAPS

G. K. Korbacher Apr. 1963 52 p 11 refs

(Grant DA-TC-44-177-G1)

(UTIA-90)

The experimental evidence for and verification of the once much disputed jet flap thrust hypothesis is scrutinized. Experimental results are found to agree with theory. Also, the development of "Jet Flap Characteristics" for quasi 2-dimensional jet-flapped wings is presented. For a specific lift, it permits reading off any number of combinations of rate of blowing, jet deflection angle and angle-of-attack. Consulting the characteristics simultaneously for the corresponding drag and thrust values adds performance and economy of operation criteria to the picture. An "operating line" for jet flapped wings results from optimizing the production of a specific lift with respect to the lowest expenditure in blowing at the smallest possible drag. Also, some simple semiempirical relationships can be derived from these jet flap characteristics which permit supplementing characteristics substantially beyond measured test points, provided that some basic "constants" of the jet flapped wing are known. Author

N63-17904 Aeronautical Research Council (Gt. Brit.)

MEASUREMENTS OF PITCHING-MOMENT DERIVATIVES FOR BLUNT-NOSED AEROFOILS OSCILLATING IN TWO-DIMENSIONAL SUPERSONIC FLOW

P. G. Pugh and L. Woodgate (Natl. Phys. Lab.) London, HMSO, 1963 19 p 7 refs

(ARC-R&M-3315; previously issued as ARC-23012) Available from HMSO: 8s.

Direct pitching-moment derivatives have been measured using the method of Scruton, Woodgate, *et al.* for two single-wedge blunt-nosed airfoils. These measurements were made at Mach numbers of 1.75 and 2.47, and frequency parameters less than 0.02. In general, nose blunting was found to have little effect on the derivatives, although changes were observed for the thinner wedge at a Mach number of 1.75. Author

N63-18019 Princeton U., N.J.
PRESSURE AND HEAT TRANSFER MEASUREMENTS OVER A CIRCULAR CYLINDER AT ANGLES OF ATTACK UP TO 15° AT M=11
C. C. Horstman Wright-Patterson AFB, Ohio, Aeronautical Research Labs., May 1963 85 p 11 refs
(Contract AF 33(616)-7629)
(ARL-63-81)

As a continuation of a fundamental study of hypersonic wings and control surfaces, some detailed pressure-distribution and heat-transfer results have been obtained about a circular cylinder, with various nose shapes, at angles-of-attack up to 15°, and at azimuth angles from zero to 180°. The tests were carried out in the Princeton University 3-inch helium hypersonic wind tunnel, at a Mach number of 11. The experimental results were compared with theory along the windward side and in the crossflow plane for both the pressure and heat-transfer distributions. Some effects of the nose shape on the flow over the circular cylinder under study were determined up to 13 cylinder diameters back from the nose. Author

N63-18041 National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.
INFLUENCE OF AUTOMATIC CONTROL OF ROLL COUPLING AND PITCH-UP ON TAIL LOADS
Ralph W. Stone, Jr. Washington, NACA, June 17, 1957 25 p 21 refs
(NACA RM-L57D18a) OTS: $2.60 ph, $0.95 mf (Declassified)

An analytical study has been made of the effects of automatic augmentation or controlling systems on the tail loads experienced in rolling maneuvers and in pitch-up. The results were calculated on an analog computer, and the equations of five-degrees-of-freedom were used for the rolling maneuvers and three-degrees-of-freedom for pitch-up. The results indicate that, for the rolling cases calculated, most automatic systems tend to reduce not only the violence of the maneuver but also the tail load encountered. However, if automatic systems are to be used, they must be considered in the initial design to obtain acceptable motions in rolls and to evaluate properly the tail loads. For the pitch-up problem, the maximum tail loads are predominantly the result of control deflection, and systems which essentially reduce the input or pull-up deflections will generally improve the acceleration overshoots, and reduce the horizontal-tail loads. Author

N63-18047 National Advisory Committee for Aeronautics. High-Speed Flight Station, Edwards, Calif.
BOUNDARY-LAYER-TRANSITION MEASUREMENTS IN FULL-SCALE FLIGHT
Richard D. Banner, John G. Mc Tigue, and Gilbert Petty, Jr. Washington, NACA, July 28, 1958 11 p 5 refs
(NACA RM H58E28) OTS: $1.60 ph, $0.80 mf (Declassified)

Chemical sublimation has been employed for boundary-layer-flow visualization on the wings of a supersonic fighter airplane in level flight, at speeds near a Mach number of 2.0. The tests have shown that laminar flow can be obtained over extensive areas of the wing with practical wing-surface conditions. In addition to the flow visualization tests, a method of continuously monitoring the conditions of the boundary layer has been applied to flight testing, using heated temperature-resistance gages installed in a Fiberglas "glove" installation on one wing. Tests were conducted at speeds from a Mach number of 1.2 to a Mach number of 2.0, at altitudes from 35,000 feet to 56,000 feet. Data obtained at all angles-of-attack, from near 0° to near 10°, have shown that the maximum transition Reynolds number on the upper surface of the wing varies from about 2.5×10^6 at a Mach number of 1.2, to about 4×10^6 at a Mach number of 2.0. On the lower surface, the maximum transition Reynolds number varies from about 2×10^6 at a Mach number of 1.2, to about 8×10^6 at a Mach number of 2.0. Author

N63-18064 Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION OF THE CHARACTERISTICS OF SOME PLANE AND CAMBERED 65° DELTA WINGS AT MACH NUMBERS FROM 0.7 TO 2.0
L. C. Squire, J. G. Jones, and A. Stanbrook London, HMSO, 1963 84 p 18 refs
(ARC-R&M-3305; previously issued as RAE-R-AERO-2655; ARC-231100) Available from HMSO: £1 12s

The results are given of an investigation of the forces on, and types of flow over, three 4% thick 65° delta wings (two plane and one conically cambered). The change in flow pattern with increase in Mach number, from one characterized by a rolled-up vortex sheet to one in which the flow is attached over the wing, is discussed with the aid of oil-flow and vapor-screen visualization of the flow, together with the basic force data. Various other phenomena were observed, notably the presence of small streamwise vortices in the boundary layer and in the separated vortex sheet, and, at the higher Mach numbers, the presence of conical shock waves in the flow above the wing. The force results showed that on all three wings the amount of nonlinear lift developed was very much smaller at supersonic than at subsonic speeds, and was in fact negative at the highest test Mach number (2.0). Also, the proportion of the full theoretical effective leading-edge suction force that was realized decreased rapidly with increase of incidence. The cambered wing developed a greater effective leading-edge suction than the plane wings, particularly at high subsonic speeds. Author

N63-18129 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LOW-SUBSONIC MEASUREMENTS OF STATIC AND DYNAMIC STABILITY DERIVATIVES OF SIX FLAT-PLATE WINGS HAVING LEADING-EDGE SWEEP ANGLES OF 70° TO 84°
Robert E. Shanks Washington, NASA, July 1963 30 p 8 refs
(NASA TN D-1822) OTS: $0.75

An investigation has been made to determine the low-speed static stability characteristics and the rolling and yawing dynamic stability derivatives of a series of thin flat-plate delta wings having leading-edge sweep angles of 70° to 84°. The investigation showed that the static longitudinal stability, the directional stability, and the effective dihedral increased with increasing sweep. The static lateral derivatives were linear at low angles-of-attack, but became increasingly nonlinear with increase in angle-of-attack and increase in sweep. The values of the rolling and yawing oscillation derivatives were generally small and relatively unaffected by sweep at the lower lift coefficients, but very large values of the derivative were obtained at the higher lift coefficients for the higher sweep angles. The theoretical prediction of the longitudinal stability, effective dihedral, and lateral oscillation derivatives (except C_{l_r}) at low lift coefficients is in fairly good agreement with the measured values. Author

N63-18136 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PRESSURE DISTRIBUTIONS ON BLUNT DELTA WINGS AT ANGLES OF ATTACK TO 90° AND MACH NUMBER OF 6.85
Peter T. Bernot Washington, NASA, July 1963 40 p 17 refs
(NASA TN D-1954) OTS: $1.00

Pressure distributions were obtained on four blunt delta-wing models having sweep angles of 50°, 70°, 75°, and 80° over an angle-of-attack range from 30° to 90°, and at a Mach number of 6.85. In general, the pressures on the windward slab surfaces are constant for angles-of-attack up to about 50°. As angle-of-attack is increased further, pressure gradients occur on both the windward slab and leading-edge surfaces. Pressures on the windward leading edges decreased as distance from the wing apex increased, with significant pressure gradients occurring in the angle-of-attack range from 50° to 90°. Modified Newtonian theory yielded only fair agreement with the measured pressures. Effect of wing sweep angle is to raise the pressure level with decreasing sweep, but this trend diminishes at angles-of-attack greater than 60°. The effect of angle-of-attack is best characterized by the fact that 90 percent of the maximum pressure rise is attained at an angle-of-attack of 70°. The measured pressures on the model center line are bracketed by the five-term hypersonic approximation and modified Newtonian theory. Author

N63-18136 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECTS OF ROUNDING CORNERS AND LEADING EDGES ON THE WINDWARD-SURFACE PRESSURES OF A DELTA WING SWEPT 65° AT A MACH NUMBER OF 5.96 AT ANGLES OF ATTACK FROM 65° TO 115° AND ANGLES OF ROLL FROM 0° TO 25° AT 90° ANGLE OF ATTACK
Theodore J. Goldberg and Doris K. Blanchard Washington, NASA, July 1963 34 p 13 refs
(NASA TN D-1959) OTS: $1.00

Detailed pressures on the windward surface of two flat-plate delta wings swept 65° and with rounded corners (one having square leading edges and the other having rounded leading edges) were obtained at a Mach number of 5.96, through an angle-of-attack range from 65° to 115°, and at angles-of-roll from 0° to 25° at an angle-of-attack of 90°. These results were compared with those previously reported for a similar wing having sharp corners and square edges. At all attitudes tested, any effect on the pressure distributions caused by rounding the corners only, or by rounding the corners and leading edges, was confined to about the last 10 percent of the radial rays emanating from the centroid of the model. The normal-force coefficient was essentially unaffected by rounding the corners only, but was decreased by approximately 4 percent by rounding the corners and leading edges. Author

04 AIRCRAFT

Includes: specific types of complete aircraft (e.g., Ground Effects Machines, Flexible Wings, STOL, and VTOL); flight tests; operating problems; stability and control.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 30 Space Vehicles.

N63-17498 Cessna Aircraft Co. Military Aircraft Div., Wichita, Kan.
AN INVESTIGATION OF MECHANICAL STABILITY AND TRIM AUGMENTATION ON HELICOPTER IFR CAPABILITY
Charles M. Seibel Ft. Eustis, Va., Army Transportation Res. Command, June 1963 55 p
(Contract DA-44-177-TC-791)

A flight-test program directed towards improved helicopter instrument flight characteristics has been conducted. Modifications and additional systems tested were of the mechanical type. Improved characteristics were observed with the application of tail rotor-blade modifications and with the application of direct-acting mechanical gyro systems. Author

N63-17499 Human Sciences Research, Inc., Arlington, Va.
SUITABILITY OF THE C-54 AS AN AIRPORT LANDING AIDS RESEARCH VEHICLE IN THE JET AGE Final Report
Wallace F. Rollins and W. S. Vaughan, Jr. Jan. 1963 55 p 23 refs
(Contract FAA/BRD-401)
(HSR-RR-62/8-MK-X)

Study purpose was to determine the generality of in-flight evaluations of airport marking and lighting (AML) systems when a Douglas C-54 is used as the test aircraft. The problem was explored from two points of view: first, the generality of C-54 flight test results to a specific class of aircraft represented by the Convair 880; and second, the problem of increasing the generality of flight test results through increasing the precision of experimental procedures. Comparative analyses were made of the Douglas C-54 and the Convair 880 in terms of pilot tasks, cockpit visibilities, and approach and landing profiles. Recommendations are made for flight test modifications to increase generality of C-54 results to Convair 880 type aircraft. Experimental procedures to increase the general applicability of flight test results are recommended. Author

N63-17533 Ryan Aeronautical Co. Aerospace Div., San Diego, Calif.
STRUCTURAL DESIGN STUDY OF A GROUND EFFECT MACHINE FOR AMPHIBIOUS SUPPORT Final Report
A. D. Le Baron Feb. 16, 1962 117 p 11 refs
(Contract Nonr-3068(00), Amendment I)
(Rept. 62B009)

This report contains the results of a structural design study of a GEM for amphibious support. The intent of the study was to establish a GEM configuration suitable for amphibious support, perform structural analysis to determine the required size of structural components, and provide the drawings and data necessary to describe the vehicle, the type of structure and method of construction. Author

N63-17568 Kellett Aircraft Corp., Willow Grove, Pa.
HELICOPTER STATIC ELECTRICITY DISCHARGING DEVICE Technical Report, Mar. to Dec. 1961
S. Blair Poteate, Jr., and Juan de la Cierva Ft. Eustis, Army Transportation Res. Command, Dec. 1962 62 p
(Contract DA-44-177-TC-728)
(TCREC-TR-62-33)

This report presents the results of a program for the alleviation of static electricity problems associated with helicopters. A static-electricity discharging device for helicopters was designed, built, and tested. Flight tests were performed with an H-37 helicopter under a number of different flight conditions. During these flights, which were conducted in a natural charging current of 2 microamperes, the discharging device maintained the electrostatic energy level at below 1 millijoule. Author

N63-17987 National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.
NACA CONFERENCE ON HELICOPTERS A Compilation of the Papers Presented at Langley Aeronautical Laboratory, Langley Field, Va., May 12 and 13, 1954
Laurence K. Loftin, Jr. et al Washington, NASA [1954] 354 p refs
OTS: $21.00 ph, $10.82 mf (Declassified)

Technical papers presented at the NACA conference on helicopters are given. This conference was held to convey the results of NACA helicopter research to the military services, their contractors, and others concerned with the design of helicopters. The papers cover the following topics: (1) rotor aerodynamics, including airfoil section characteristics, rotor induced flow, hovering, forward flight, and multirotor configurations; (2) propulsion and parasite drag, including blade tip propulsion, internal flow, parasite drag, and noise; (3) stability and control, including flying-qualities criteria, and design methods and data; and (4) loads, stresses, vibration, and flutter. M.P.G.

N63-17991 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
HIGH-ALTITUDE PERFORMANCE OF A 64-FOOT-DIAMETER RING SAIL PARACHUTE
Max C. Kurbjun Washington, NASA, Dec. 1959 15 p 1 ref
(NASA TM X-232) OTS: $1.60 ph, $0.80 mf (Declassified)

Aerial drop tests have been conducted to measure the loads and descent characteristics of a 64-foot-diameter Ring Sail parachute carrying a full-scale orbital capsule. The parachute was deployed from the capsule at 10,000 feet at a terminal velocity of 225 fps. Parachute reefing was varied in the test series and the opening-load time histories recorded. The results show that the parachute, when reefed to 10 percent of the nominal parachute diameter for 6 seconds, gave the lowest loading time history. Decreasing the reefing time to 4 seconds increased the opening load by 25 percent; a further reduction would eliminate most of the benefit derived from reefing the parachute. Increasing the reefed area of the parachute by factors of 2 and 3 increased the reefed opening load by 30 percent and 80 percent, respectively, over the 10-percent reefing condition. Rate of descent of the parachute and capsule was 33 fps at 5,000 feet and 30.6 fps at sea level. Oscillation of the parachute and capsule was estimated to be ±20° from the vertical with a period of 5 seconds. Author

N63-17993 National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
REVIEW OF TECHNIQUES APPLICABLE TO THE RECOVERY OF LIFTING HYPERVELOCITY VEHICLES
Joseph Weil and Gene J. Matrange Washington, NASA, Sept. 1960 17 p 3 refs
(NASA TM X-334) OTS: $1.60 ph, $0.80 mf (Declassified)

A general review of piloting problems concerned with the recovery phase of lifting hypervelocity vehicles is presented. A short discussion is offered pertinent to the maneuvering capabilities and piloting techniques applicable to the initial-approach phase of gliders with low lift-drag ratios. The principal emphasis concerns factors affecting the final-approach and landing operation of these gliders. The results of general flight studies, as well as recent experience obtained in the approach and landing of the X-15 research airplane, are reviewed. A definition of the limits of piloted flared landings is developed. Author

N63-18029 Army Missile Command. Army Inertial Guidance and Control Lab., Redstone Arsenal, Ala.
DIFFERENCE BETWEEN SUNRISE (SUNSET) TIMES FOR MISSILES AND THEIR LAUNCH SITES
W. F. Baxter and C. F. Asquith May 24, 1963 18 p
(AMC-RG-TR-63-12)

Sensing elements carried by certain missiles may be damaged by direct sunlight. It is, therefore, important in these cases to be able to choose a firing time when the missile will not emerge from the earth's shadow. The objective of this report is to determine the difference in time of sunrise on the ground and time of sunrise for a missile at a specified height. The same is done for sunset. Author

N63-18039 National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
INVESTIGATION OF THE CHARACTERISTICS OF 6-FOOT DROGUE-STABILIZATION RIBBON PARACHUTES AT HIGH ALTITUDES AND LOW SUPERSONIC SPEEDS
Clinton T. Johnson Washington, NASA, Nov. 1960 38 p 8 refs
(NASA TM X-448) OTS: $3.60 ph, $1.34 mf (Declassified)

Performance data are presented for two types of ribbon parachutes. The parachutes were forcibly deployed from an air-launched test vehicle at altitudes from 55,000 feet to 70,000 feet, and at Mach numbers between 0.92 and 1.52. Opening shock, steady-state drag performance, and canopy-porosity effects are evaluated with respect to Mach number and dynamic pressure. The conical canopy design appears to function far better than the flat canopy at supersonic deployment speeds. The relatively high-porosity conical design improves the parachute stability, with the added benefit of a low opening shock. The drag efficiency of the conical canopy is equivalent to that of the flat canopy having 50-percent-lower porosity. Riser elasticity and length also appear to be important parameters affecting the parachute stability. Reducing the weight of the test vehicle by a factor of one-third had a negligible effect on the stability and drag characteristics of the parachute. Author

N63-18044 National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.
STATIC STABILITY AND CONTROL OF HYPERSONIC GLIDERS
Robert W. Rainey Washington, NACA, July 7, 1958 16 p 2 refs
(NACA RM L58E12a) OTS: $1.60 ph, $0.80 mf (Declassified)

A study has been made of the static stability and control problems associated with several hypersonic boost gliders. It appears that, in general, it is possible to obtain the desired trim features. The flat-top configuration was found to be essentially self trimming, whereas for the flat-bottom configuration, negative camber provided an effective means to trim. Furthermore, at the low angles-of-attack, directional stability and control were adequate for the complete configurations investigated. Author

N63-18046 National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.
DYNAMIC LATERAL BEHAVIOR OF HIGH-PERFORMANCE AIRCRAFT
Martin T. Moul and John W. Paulson Washington, NACA, Aug. 6, 1958 11 p 1 ref
(NACA RM L58E16) OTS: $1.60 ph, $0.80 mf (Declassified)

Several proposed high-performance aircraft have been studied analytically, and by model flight tests, to define some problem areas in dynamic lateral behavior of high-speed aircraft which require specific attention. In particular, aileron control problems and Dutch roll characteristics, with and without artificial damping, were considered. The results indicate that effective dihedral and cross-control derivatives can have gross effects on the lateral stability and controllability of hypersonic gliders. Author

N63-18060 All American Engineering Co., Wilmington, Del.
DEVELOPMENT OF MODEL 3500 ARRESTING GEAR AND CONTINUED DEVELOPMENT OF SPRING HOOK FOR COMMERCIAL AIRCRAFT, PART I Final Report
W. R. Schlegel Jan. 1963 159 p
(Contract FAA-ARDS-437)

This report summarizes the work involved in the development of the Model 3500 Arresting Gear for emergency use with large commercial aircraft. The utilization of a large gas turbine launcher, dead load design to simulate aircraft mass, the continued development of the Sheaffer Spring Hook, and actual aircraft testing are discussed. Author

N63-18065 All American Engineering Co., Wilmington, Del.
DEVELOPMENT OF MODEL 3500 ARRESTING GEAR AND CONTINUED DEVELOPMENT OF SPRING HOOK FOR COMMERCIAL AIRCRAFT, PART II Final Report
A. Russo, Jr. Jan. 1963 90 p 5 refs
(Contract FAA-ARDS-437)

The fuselage stresses, fuselage accelerations, and engine accelerations obtained on the FAA Boeing 727-027, N-113, during arrestments into the Model 3500 Arresting Gear, at speeds through 135.6 knots, and gross weights through 220,000 pounds were within safe working levels. A summary of stresses as obtained by strain measurement are shown. Author

N63-18173 Federal Aviation Agency. Office of Management Services, Washington, D.C.
COMMERCIAL SUPERSONIC TRANSPORT AIRCRAFT RESEARCH PROGRAM. SELECTED REFERENCES—BIBLIOGRAPHIC LIST NO. 8.
Apr. 1963 41 p 379 refs

05 ASTRONOMY AND ASTROPHYSICS

Includes: celestial mechanics; and radioastronomy.

For related information see: 12 Geophysics; and 29 Space Sciences.

N63-17509 Lincoln Lab., Mass. Inst. of Tech., Lexington
RADAR ASTRONOMY 14th Reference Bibliography [Period covered, 1946-Aug. 1962]
Jean E. Britton and Paul E. Green, Jr. Dec. 31, 1962 18 p 151 refs
(Contract AF 19(628)-500)
(AD-294683; MIT-H-462) Available LL: $4.15

A bibliography of radar investigations of astronomical problems, excluding topics within the earth's environment, is presented. It includes theoretical articles as well as those giving experimental data and descriptions of equipment. The period from 1946 to August 1962 is covered. No abstracts are included. M.P.G.

N63-17540 Liege U. (Belgium)
RESEARCH ON RELATIONS BETWEEN COMETARY, SOLAR AND UPPER ATMOSPHERIC PROCESSES Annual Summary Report, 1 Apr. 1962-31 Mar. 1963
P. Swings et al Apr. 24, 1963 25 p refs
(Contract AF 61(052)-587)
(AFCRL-63-648)

Laboratory work has been carried on time resolution of spectra in the vacuum ultraviolet, on the spectra of several molecules of astronomical interest, and on miscellaneous laboratory instrumentations. Physical mechanisms of cometary physics have been discussed on the basis of new observational material. Remarks are made on various space experiments. Author

N63-17550 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
COSMIC-RAY-INDUCED STABLE AND RADIOACTIVE NUCLIDES IN METEORITES
Michael E. Lipschutz Washington, NASA, June 1963 12 p 38 refs For presentation at the Symp. on Space Radiation of the American Soc. for Testing and Materials, Atlantic City, June 23-28, 1963
(NASA TN D-1844) OTS: $0.50

Meteorites, the only extraterrestrial solid objects currently available on the earth, are being extensively studied by many investigators. Data now available enable us to reconstruct some features of that period when meteorites were exposed to cosmic rays. A brief discussion of meteoritic types is followed by presentation of the results of radiochemical and mass-spectrometric investigations on meteorites. From the amounts of cosmogenic stable and radioactive species present, conclusions can be drawn concerning the duration of cosmic ray exposure, the spectrum and intensity of the incident cosmic ray flux, the preatmospheric size and shape of the meteorites, and the terrestrial history of these objects. Also, a brief discussion of some, as yet unanswered, questions concerning meteorites is presented. Author

N63-17580 Observatorium Bosscha, Bandung (Indonesia)
PHOTOMETRY OF THE GALACTIC CLUSTER NGC 6649
Pik-Sin The and Curt Roslund (Lund Observatory, Sweden)
Feb. 1963 13 p 11 refs
(*Its* Contrib. No. 19)

By using photoelectric and photographic techniques, magnitudes and colors in the Johnson UBV system are given for eighty stars in the galactic cluster NGC 6649. The apparent visual distance modulus of NGC 6649 is 14.2 mag., the color excess is 1.2 mag., and the true modulus 10.6 mag., corresponding to a distance of 1300 parsecs. The photoelectric observations show that one of the stars in the cluster NGC 6649 is a possible Cepheid variable. Author

N63-17664 RAND Corp., Santa Monica, Calif.
RADIATIVE TRANSFER IN A PLANETARY ATMOSPHERE WITH IMPERFECT SCATTERING
Zdenek Sekera June 1963 76 p 15 refs
(AF 49(638)-700; Proj. RAND)
(R-143-PR)

The problem of radiative transfer in a plane-parallel medium that exhibits scattering and absorption is solved. It can be used to compute the intensity and polarization of radiation emerging from an absorbing atmosphere. The solution was obtained for the so-called inhomogeneous case, in which the absorption coefficient varies within the medium. Hence, this theoretical model represents an atmosphere in which the absorbing power is changed by temperature dependence or pressure broadening of the absorption lines. The theoretical results can be readily applied to the radiation emerging from a planetary atmosphere, both in the ultraviolet absorption region of ozone and oxygen, and in the near-infrared region where the atmospheric constituents have vibration-rotational absorption bands. Author

N63-17719 Royal Observatory, Edinburgh (Gt. Brit.)
REPORT OF THE ASTRONOMER ROYAL FOR SCOTLAND FOR THE YEAR ENDING 31ST MARCH 1963
H. A. Brück Mar. 31, 1963 16 p 11 refs

The status of the Royal Astronomical Observatory, Edinburgh, Scotland, is reported. Included are: observations made with the 36-inch telescope—the spectrophotometry of F- and G-Type stars, and observations of the lambda-4430 A interstellar band; spectrophotometry and three-color photometry with the 16/24-inch Schmidt telescope; the description of new equipment and the twin 16-inch automatic telescope; the photometry of southern star clusters; space research; the tracking of artificial satellites; the rotation of B-stars; a new type of image tube; an optical correlator; and the report of the electronics laboratory. D.E.R.

N63-17792 International Astronomical Union, Hailsham (Gt. Brit.)
TRANSACTIONS OF THE INTERNATIONAL ASTRONOMICAL UNION. VOL. XIB – PROCEEDINGS. PROCEEDINGS OF THE ELEVENTH GENERAL ASSEMBLY, BERKELEY, 1961
D. H. Sadler, ed. New York, Academic Press, 1962 537 p refs
(NASA Grant NsG-141-61)
(NASA CR-50238) Available from Academic Press: $11.50

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5. JOINT DISCUSSIONS
   - A. STELLAR MOTIONS AND STELLAR DYNAMICS p 393–418 refs
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   - D. PROBLEMS REQUIRING RADIO-ASTRONOMICAL OBSERVATIONS OF HIGH SENSITIVITY AND RESOLUTION p 463–467
   - E. REPORT OF MEETING OF THE INTER-UNION COMMISSION ON SOLAR AND TERRESTRIAL RELATIONSHIPS p 469–474
6. STATUTES AND BY-LAWS; EXECUTIVE COMMITTEE: MEMBERSHIP OF COMMISSIONS; ALPHABETICAL LIST OF MEMBERS p 475–532

N63-17793 Princeton U. Observatory, N.J.
STELLAR EVOLUTION
M. Schwarzschild *In* International Astronomical Union, Hailsham (Gt. Brit.) Transactions of the Intern. Astron. Union. Vol. XIB-Proc. Proc. of the Eleventh Gen. Assembly, Berkeley, 1961 p 137–143 (See N63-17792 16-05)

Theories of stellar evolution are reviewed. Evidence for the evolution of most of the heavenly bodies is presented which is based on the fact that the radiant luminosity of a star represents a persistent, enormous energy loss. The processes which govern the evolution of stars are then discussed: (1) nuclear processes — evolutionary processes occurring when the star is in thermal and dynamic equilibrium and when nuclear transmutations, by alteration of the chemical composition, are the only cause for any change; (2) thermal processes — evolutionary processes occurring when the star is in dynamical equilibrium but not in thermal equilibrium, causing the release of thermal or gravitational energy during contraction of the stellar mass; and (3) dynamical processes — evolutionary processes governing the fastest rate of stellar evolution (when the star is not in dynamical equilibrium) and leading to a supernova explosion, to a nova outburst, to radial pulsations, and mass ejection. D.E.R.

N63-17794 Academy of Sciences of the Armenian SSR, Erevan (USSR)
PROBLEMS OF EXTRA-GALACTIC RESEARCH
V. A. Ambartsumian *In* International Astronomical Union, Hailsham (Gt. Brit.) Transactions of the Intern. Astron. Union. Vol. XIB-Proc. Proc. of the Eleventh Gen. Assembly, Berkeley, 1961 p 145–160 refs (See N63-17792 16-05)

The theories of extragalactic astronomy and cosmology are discussed to show their applicability to Einstein's theory of gravitation. The distribution of matter in extragalactic space, the kinematics and dynamics of galactic systems, the nature of other galaxies and their clusters, the phenomena of superposition, and the phenomena of instability are outlined. The activity of the galactic nuclei is determined to be the most important process in the life of the galaxies. Unsolved problems include determining (1) whether all galaxies possess nuclei, (2) the characteristics of nonnuclear galaxies, (3) the integral characteristics of galactic nuclei. Other problems to be resolved are determining the parameters of the nuclei and the galaxies, the spectra of the nuclei, and the relation between the nucleus and the bar in barred galaxies. D.E.R.

N63-17796 Konkoly Observatory, Budapest (Hungary)
PROBABLE SUPERNOVA. ON THE SUPERNOVA IN NGC 4178
C. Hoffmeister and K. Löchel (Sonnenborgh Obs.) June 12, 1963 2 p
(Comm. 27 of the I.A.U. Inform. Bull. on Variable Stars No. 30)

A comparison of astrographic plates between March 1, 1963, and March 4, 1963, showed a southerly extension of a small galaxy in Coma. The extension is somewhat fainter than the undisturbed galaxy and has a combined brightness of 16^{m}. A comparison of the astrographic plate taken April 22, 1963, with one taken February 21, 1938, was made of the Virgo-Cluster. The former plate shows a nucleus formed by two star-like condensations with another star-like object proceeding south in the galaxy NGC 4178. These observations are not noted in the 1938 plate. A second plate of May 20, 1963, confirms this object as a Supernova. N.E.A.

N63-17797 Konkoly Observatory, Budapest (Hungary)
NOVA URSAE MINORIS 1956
F. Börngen (Tautenburg Obs.) June 10, 1963 1 p 2 refs
(Comm. 27 of the I.A.U. Inform. Bull. on Variable Stars No. 29)

Photographs were taken of the Nova Ursae Minoris 1956 to confirm its brightness and spectral type. The photos were taken in the ultraviolet, blue, violet system with the Tautenburg Schmidt camera. The data of these expositions as well as the resulting magnitudes of the Nova are presented as $B = 16^{m}.7$, $U = 16^{m}.35$, $V = 17^{m}.2$, and $B = 17^{m}.0$, reduced to equal zenithal distance. The color indices for the Nova $(U - B) = -0.65$ and $(B - V) = -0.2$ are derived from the magnitudes. Supposing that the Nova did not change brightness during exposure time and assuming that it is a main sequence star, the spectral type B 3 is derived for the Nova. D.E.R.

N63-17798 Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.
THE THEORY OF THE SOLAR WIND
E. N. Parker N.Y., AIAA [1963] 7 p 18 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963
(NASA Grant NsG-96-60)
(AIAA Paper 63-253) AIAA: $0.50 members, $1.00 nonmembers

The corona of a star like the sun is tightly bound to the star by the gravitational field. The $10^{6\circ}$ K temperature of the corona is maintained by thermal conduction and/or active coronal heating for distances of several stellar radii into space. The result of the combination of the tight binding and the extended temperature is a continual hydrodynamic expansion of the outer corona into space to form a tenuous wind blowing outward from the star with supersonic velocity. Recent observations in space indicate that the velocity of the wind from the sun is 300 to 600 km/sec. in agreement with the theoretical estimates based on the temperature of the corona observed near the sun. The density is observed to be 2 to 20 atoms/cm^3 at the orbit of earth, which falls within the broad range of densities permitted by the observed coronal temperature. The supersonic solar wind is identifiable as the "solar corpuscular radiation," postulated for many years now to explain geomagnetic activity, aurorae, cosmic ray variations, comet tail behavior, etc. Author

N63-17877 Konkoly Observatory, Budapest (Hungary)

NOVA URSAE MINORIS 1956

P. Ahnert (Sonnenborgh Obs.) and W. Stroheier (Remeis Obs., Bamberg) Jan. 30, 1963 2 p
(Comm. 27 of the I. A. I. Inform. Bull. on Variable Stars No. 19)

A review of the observations of the Nova Ursae Minoris 1956 seems to indicate that it was galactic Nova with somewhat unusual but not impossible position and amplitude. I.v.L.

N63-17878 Konkoly Observatory, Budapest (Hungary)

NOVA OR SUPERNOVA

B. V. Kukarkin (Sternberg Astron. Inst.) Dec. 30, 1962 2 p
(Comm. 27 of the I. A. U. Inform. Bull. on Variable Stars No. 18)

A star discovered on old sky-patrol plates had the given position: RA (right ascension) = $16^h\ 51^m\ 54^s$; decl. = $+77^\circ$ 12.3 (1900.0); l^{II} (longitude; galactic coordinate) = $109^\circ.6$; b^{II} (latitude; galactic coordinate) = $+33^\circ.2$. Before September 8, 1956, the star was invisible. On September 24, 1956, the star had a magnitude about 6^m and in September 1957 its brightness was about $11\overset{m}{.}5$. Later, the star became visible again; its magnitude was estimated to be about 10^m. The star was not seen on December 14, 1962, and was also invisible on the Palomar Sky Atlas Chart No. 1433-0 of May 19, 1955. The photometric behavior of this star is very similar to those of Type I supernovae. The following four assumptions were made concerning the star: (1) The star may be a slow galactic nova with absolute magnitude $M = -6$. The very large amplitude (15^m) and the great distance from the galactic plane (about 1 to 2 kps) are in disaccord with this assumption. (2) The star may be an unusual faint galactic supernova with $M = -12$. The great distance from the galactic center (about 35 to 45 kps) contradicts this assumption. (3) The star may be a normal Type I supernova with $M = -18$. In this case, its distance would be about 200 to 300 kps. But no bright galaxies can be seen in the star's neighborhood. Hence the star may be an intergalactic supernova. (4) The star may be a normal Type I supernova with $M = 0.18$ in a very faint galaxy similar to the Sculptor or Draco systems. If the distance modulus is about 24^m, the brightest stars in the system would not be visible on the Palomar Charts. N.E.A.

N63-17879 Konkoly Observatory, Budapest (Hungary)

UNUSUAL NEW VARIABLE S 7901 CYGNI

C. Hoffmeister (Sonnenborgh Obs.) Feb. 7, 1963 2 p
(Comm. 27 of the I.A.U. Inform. Bull. on Variable Stars No. 20)

The discovery of a new variable star, S 7901 Cygni, is reported. The variability of this star is most unusual. The full range variations, from 14.8 to 16.5 in magnitude, are shown only on plates from March and April, 1953. The star is faint on a single plate of Jan. 13/14, 1953, and a few minima (1 in magnitude) are observed on plates of May and June of that year. However, no variability or very slight variability (less than 0.2 in magnitude) appears in plates from 1952 or the second half of 1953, when the star was generally at maximum light. This variable star is classified as the RW Aurigae type whose variability can be interrupted at any brightness; S 7901 Cygni appears to be unique in the duration of its period of stable brightness. The possibility that other stars, such as RW Aql, originally reported as variables but classified in the catalogs as invariable, may be of the same type as S 7901 Cygni is suggested. M.P.G.

N63-17880 Konkoly Observatory, Budapest (Hungary)

NEW VARIABLE STARS [NOUVELLES ÉTOILES VARIABLES]

R. Weber (Station Astro-Photographique de Mainterne, France)
Feb. 28, 1963 3 p
(Comm. 27 of the I.A.U. Inform. Bull. on Variable Stars No. 21)

Two tables are presented that give the pertinent data on 12 newly discovered variable stars, including: numerical classification of the stars (Wr = 119 to 139), positions in the sky, magnitudes at maximum and minimum brightnesses, spectral types, density, and the apparent magnitude at four locations in the orbit of each of these variable stars. D.E.R.

N63-17881 Konkoly Observatory, Budapest (Hungary)

A NEW BRIGHT ECLIPSING VARIABLE W. Strohmeier (Remeis Obs., Bamberg) AT HERCULIS E. Illes-Almar

Mar. 25, 1963 1 p 1 ref
(Comm. 27 of the I.A.U. Inform. Bull. on Variable Stars No. 22)

A star has been classified as a variable of RR Lyrae-type with a period of $0\overset{d}{.}33$. A spectrogram was taken of the star and, based on the relative strengths of the spectral lines, the star has been classed in the MK system as KO V; consequently, it cannot be referred to the pulsating variable stars. C.L.W.

N63-17903 High Altitude Observatory, Boulder, Colo.

PHYSICAL CONDITIONS IN LIMB FLARES AND ACTIVE PROMINENCES. VI. SELECTIVE EXCITATION CONDITIONS

Einar Tandberg-Hanssen [1963] Repr. from Astrophys. J., v. 137, no. 1 Jan. 1963 p 26–37 16 refs Previously announced as a preprint, see N62-12492 08-28
(NASA Grant NsG-92-60)
(NASA CR-50315)

The complex surge prominence of November 18, 1960, is studied spectroscopically. It is shown that the surge consists of different regions, where the physical conditions (temperature and/or internal motions) differ from one region to another. The metal and helium regions are shot out from an underlying flare in different directions. The emission from Fe II is considerably fainter than that from Ti II or Ba II. A finer spectroscopic classification of flares and prominences than that previously introduced is discussed. As a general rule, while Ti II lines are stronger than Fe II lines in prominences, the reverse holds true in flares. As a new classification criterion, the line-intensity ratio $M = [I(\text{Fe II}, 4584)/I(\text{Ti II}, 4572)]$ is introduced. Author

N63-17927 Aerospace Information Div., Library of Congress, Washington, D.C.

ON THE POSITIVE CHARGE OF THE SUN [O POLOZHITEL'NOM ZARYADE SOLNTSA]

V. Krat (Main Astronomical Observatory, Pulkovo, USSR) June 11, 1963 7 p 4 refs Transl. into ENGLISH from Doklady Akad. Nauk SSSR (Moscow), v. 55, no. 3, 1947 p 207–210
(AID Rept. T-63-82) OTS: $1.10 ph, $0.80 mf

Equations for computing the charge of the sun are developed proceeding from the principle of the stationary state for the dispersion of charged particles. These equations deal with the dependency, upon gravitational forces, of the escape velocity of a particle from the sun thermal dissipation; dissipation resulting from radioactive decay and from the disintegration of atoms under impact of fast particles such as cosmic rays; the thermal dissipation of a cloud of ionized hydrogen ejected with considerable velocity beyond the limits of the inner corona; and the velocity distribution of the particles within this cloud. It is pointed out that the outer corona, in which, for the most part, only directed particles move, must to a considerable degree consist of slow ("cold") particles. It is possible that the Fraunhofer spectrum of the outer corona is created by this cold, slowly scattering, swarm of particles. I.v.L.

N63-18128 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ON A CONSISTENT SYSTEM OF ASTRODYNAMIC CONSTANTS
Helmut G. L. Krause Washington, NASA, July 1963 49 p 58 refs
(NASA TN D-1642) OTS: $1.25

An internally consistent system of astrodynamic constants is derived, based upon theoretical coupling relationships and the most recent available experimental data. A previously existing discrepancy in the value of the gravitational parameter of the earth (as derived by different methods) has been eliminated. Likewise, several inconsistencies in the previously available system of lunar constants have been removed. An error study of each constant is presented; both relative and absolute probable errors are listed. The results of this study can be summarized in the given list of astrodynamic constants. Author

06 AUXILIARY SYSTEMS

Includes: fuel cells and solar cells; gas turbines; hydraulic, pneumatic and electrical control systems and actuators; and inverters.

For primary propulsion systems see: 27 Propulsion

For related information see: 08 Communications; 09 Electronics; 10 Facilities; 15 Instrumentation; and 22 Navigation and Guidance.

N63-17497 North American Aviation, Inc. Space and Information Systems Div., Downey, Calif.
FLIGHT TEST CRITERIA FOR RE-ENTERING NAP-SYSTEM
Final Report
M. E. Sorte and John J. Sichuck Kirtland AFB, N. Mex., Development Directorate, Apr. 1963 192 p 15 refs
(Contract AF 29(601)-5104)
(SID-63-39; AFSWC-TDR-63-14)

A study has been made of nuclear auxiliary power (NAP) systems reentering the earth's atmosphere at the conclusion of a space mission. A representative NAP system was used which included the SNAP 10A unit attached to an Agena B space vehicle. It was concluded that the total integrated heat input during a flight test must be equal to the actual reentry case. The test reentry trajectory must, therefore, include higher than orbital reentry speeds for steeper reentry angles to compensate for the shorter test reentry periods of heat input. Tests involving fuel elements must use true-scale specimens, since the total heat required for ablation is proportional to rod diameter. The analysis conducted using the representative system indicates that fuel-element ablation during reentry is unlikely. The maximum altitude for expected exposure of the fuel rods is at least 50,000 feet below the minimum altitude required for fuel-element exposure to insure ablation, based on an analysis using two-dimensional heat flow. Author

N63-17728 California U., Los Angeles. Brain Research Inst.
APPLICATION OF PHASE DETECTION AND AVERAGING TECHNIQUES IN COMPUTER ANALYSIS OF EEG RECORDS IN THE CAT
W. R. Adey and D. O. Walter Repr. from Exp. Neurol., v. 7, no. 3 Mar. 1963 p 186–209 23 refs
(NASA Grant NsG-203-62; NIH Grant B-1883; Grant AF-AFOSR-61-81)

Consistency of phase patterns in EEG records from the hippocampal system and midbrain reticular formation have been examined in the course of behavioral training in five cats with implanted electrodes. These studies have involved novel application of computing techniques, including continuous measurement of phase and amplitude characteristics of single wave trains by digital filtering techniques, the use of cross-spectral analyses with calculation of complex transfer functions, and averaging of records during repeated behavioral performances with calculation of coherence functions in cross-spectral examinations. It was found that rhythmicity appeared in the computed average at the rate of the dominant EEG frequency as T-maze performance reached a high level, and was related to a reduction in scatter in phase patterns at high performance levels. Reversal of behavioral cues was associated with an immediate brief increase in rhythmicity of the average, then a decline followed by a progressive reemergence of rhythmicity at the end of retraining. Continuous phase-and-amplitude examinations during delayed response performance indicated a rhythmic phase modulation on wave trains with an apparently single frequency appearing during periods of discrimination. Comparison of probability bounds in cross-spectral analysis with use of a polar coordinate display have indicated major differences in phase relations between different hippocampal regions between correct responses in certain circumstances, with consistency in different examinations. These findings are discussed in relation to a stochastic model of the cerebral system, with reference to the possible role of the wave process in handling and storage of information. Author

N63-17806 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE SOLAR POWER SUPPLY SYSTEM FOR THE ORBITING ASTRONOMICAL OBSERVATORIES
Carl J. Wenzinger and Henry Carleton (NASA. Marshall Space Flight Cen.) N.Y., AIAA 1963 11 p 3 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963
(AIAA Paper 63-217) AIAA: $0.50 members, $1.00 nonmembers

The power subsystem of the Orbiting Astronomical Observatory is described with regard to the power requirements of the satellite, the equipment of the conversion system, and the solar power generating system. The system is designed to convert the solar radiation incident upon the Observatory to useful electrical power for a period of at least one year. Since the orbit of the Observatory exposes the satellite to alternate periods of light and darkness, the power system also stores electrical energy for use during periods of eclipse, and includes equipment for the regulation, conversion, inversion, distribution, and protection of power. D.E.R.

N63-17923 Westinghouse Electric Corp. Aerospace Electrical Div., Lima, Ohio
THE EFFECT OF SYSTEM PARAMETERS ON SPACE ELECTRIC POWER SYSTEM WEIGHTS
C. L. Doughman and F. C. Stump N.Y., AIAA [1963] 9 p 1 ref Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963
(NASA Contract NAS5-1234)
(AIAA Paper 63-243) AIAA: $0.50 members, $1.00 nonmembers

Recognition of the possible effects of the electrical conversion and control components on space vehicles using ion-thrust devices resulted in this study. Parametric data were needed to evaluate the usefulness of this type of propulsion, and to realistically determine the limitations of this vital link in space power systems. Examination is made of suitable component designs as to characteristics and limitations based on the predicted state-of-the-art in the near future. Component designs are summarized for three systems meeting specific output requirements at a power level of 1.0 megawatt. Author

N63-17931 Army Signal Research and Development Lab., Fort Monmouth, N.J.
FUEL CELLS Third Status Report
Herbert H. Hunger, Fritz R. Franke, and John J. Murphy June 1, 1962 128 p 53 refs

Relatively good performances have been obtained with saturated hydrocarbons in high-temperature cells. In the low-temperature type cells, very low performances have been obtained. Partially oxygenated hydrocarbons (e.g., alcohols) show promising performances in low-temperature cells; however, in acid electrolytes, which are essential for a removal of the reaction product carbon dioxide from the battery, unusually high polarizations at low drain are observed with methanol, formic acid, glycol, and glycerol. These polarizations correspond to cell efficiencies of about 20%. Author

N63-17932 Sundstrand Aviation-Denver, Denver, Colo.
INVESTIGATION OF A 15-KW SOLAR DYNAMIC POWER SYSTEM FOR SPACE APPLICATION. APPENDICES A THROUGH D Interim Summary Report [June 1, 1960-June 1, 1962]
K. E. Nichols Nov. 1962 342 p In two vols.
(Contract AF 33(616)-7128)
(ASD-TDR-62-1002)

Conceptual experimental hardware components have been designed. Through system studies, a full-scale design was created consisting of an inflatable concentrator, a solar-energy divider, a double-cavity heat receiver-storage unit, a multistage turboalternator assembly running on rubidium-lubricated hydrodynamic bearings, and a radial flow radiator-condenser. Feasibility studies and designs were completed for an orientation system which minimizes reaction-forces fed back to an assumed vehicle. Studies were completed for the integration and erection of the space power system (SPS) with an assumed vehicle. These last two items indicated the 15-kw SPS to be easily adaptable to a variety of vehicles and missions, on the basis of proposed booster and space vehicle volumes and diameters. Author

N63-18131 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EARTH REFLECTED SOLAR RADIATION INCIDENT UPON AN ARBITRARILY ORIENTED SPINNING FLAT PLATE
Fred G. Cunningham Washington, NASA, July 1963 39 p 8 refs
(NASA TN D-1842) OTS: **$1.25**

A general derivation is given for the earth-reflected solar radiation input to a flat plate — a solar cell paddle, for example — which is spinning about an axis coincident with the axis of symmetry of the satellite to which it is affixed. The resulting equations are written for the general case, so that arbitrary orientations of the spin axis with respect to the earth-satellite line, and arbitrary orientations of the normal to the plate with respect to the spin axis, can be treated. The equations governing the integration limits are given. The appendixes contain: the results, in graphical form, of two representative examples; the general computer program for the calculation, given in FORTRAN notation; and the results of a calculation of the distribution of albedo energy on the proposed Echo II satellite. The value of the mean solar constant used is 1.395 x 10^6 erg/cm^2-sec; the mean albedo of the earth is assumed to be 0.34; and the earth is assumed to be a diffuse reflector.

Author

07 CHEMISTRY

Includes: chemical analysis and identification (e.g., spectroscopy); chemical engineering; chemical properties of materials; and synthesis.

For related information see: 18 Materials, Metallic; 19 Materials, Non-metallic; and 26 Propellants and Combustion.

N63-17480 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
GASES IN TEKTITE BUBBLES
John A. O'Keefe, Paul D. Lowman, Jr., and Kenneth L. Dunning (Naval Res. Lab.) Repr. from Science, v. 137, no. 3525, July 20, 1962 p 228 8 refs

Spectroscopic analysis of light produced by electrodeless discharge in a tektite bubble showed the main gases in the bubble to be neon, helium, and oxygen. The neon and helium have probably diffused in from the atmosphere, while the oxygen may be atmospheric gas incorporated in the tektite during its formation. Author

N63-17482 Franklin Inst. Labs. for Research and Development, Philadelphia, Pa.
PREPARATION AND EVALUATION OF HIGH PURITY BERYLLIUM Quarterly Progress Report, Jan. 15 to Apr. 14, 1963
G. E. Spangler, M. Herman, E. J. Arndt, D. B. Hoover, V. V. Damiano, and C. H. Lee [1963] 27 p 8 refs
(Contract NOw-62-0536-D)
(Q-B2089-1)

Progress is reported in a program designed to produce high purity beryllium and to study its deformation and fracture characteristics. Included are: zone refining, single crystal and polycrystalline studies, electron transmission microscopy, and self-diffusion in beryllium studies. An automating device is described which is designed to increase the effectiveness of the zone purification system for the melting process. D.E.R.

N63-17515 Knolls Atomic Power Lab., Schenectady, N.Y.
AQUEOUS CORROSION OF ZIRCONIUM SINGLE CRYSTALS
A. E. Bibb and J. R. Fascia Oct. 1962 17 p 10 refs
(Contract W-31-109-eng-52)
(KAPL-2257) OTS: $0.50

Single-crystal wafers of zirconium have been exposed to 680° F neutral water. The single crystals were of known orientation, and weight-gain data as a function of crystal orientation were obtained. These data show that all the crystal faces studied obeyed a cubic rate law out to the time of transition; whereupon, the crystals corroded at an approximately linear rate. The time to transition varied from 114 days for $(10\bar{1}4)$ crystals to about 325 days for the $(21\bar{3}0)$ faces. The epitaxial relationship between metal and monoclinic oxide was found to be $(0001) // (1\bar{1}1)$ and $[11\bar{2}0] // [10\bar{1}]$. A black, tight, adherent oxide layer was formed on the crystals in the pretransition range. This black oxide was found to be monocrystalline. The white corrosion product produced after transition was found to be polycrystalline but highly oriented. X-ray line-broadening studies found that the black oxide was a highly strained structure; whereas, the white oxide was relatively strain free. These results indicate that a strain-induced recrystallization or fragmentation accompanies the change from protective black oxide to nonprotective white oxide. Author

N63-17530 Goodyear Aircraft Corp., Akron, Ohio

SOLAR REFLECTOR FOAMING TECHNOLOGY **First Quarterly Progress Report [Nov. 19, 1962–Jan. 31, 1963]**

Feb. 1963 47 p 4 refs
(Contract AF 33(657)-10165)
(GER-11012)

Projects discussed include: mixer design characteristics, foam formulation evaluations during the mixing cycle, optical and thermal properties of reflective foam and foam composites, and two-foot-diameter mirrors of the inflatable type that will be foamed and rigidized in a vacuum chamber. J.A.J.

N63-17532 Rock Island Arsenal Lab., Ill.

SYNTHESIS AND EVALUATION OF POLYURETHANE ELASTOMERS **Technical Report**

W. M. Vercoeven Apr. 17, 1963 15 p 9 refs
(RIA-63-1242) OTS: $0.50

Commercially available castable, millable and/or injection moldable polyurethane elastomers were evaluated to determine their characteristics and potential use for Army applications. Experimental polyurethanes were synthesized using various polyols, polyamines and stabilizing agents in an effort to improve the heat stability in the range 149° to 204° C. It was shown that retention of strength at elevated temperature can be improved by increased functionality in the system, but only at the expense of the elastic characteristics of the material. The increased crosslinking of the millable gums offers the most promise for heat-resistant polyurethanes. Author

N63-17544 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

STUDY OF THE NONEQUILIBRIUM FLOW FIELD BEHIND NORMAL SHOCK WAVES IN CARBON DIOXIDE

John T. Howe, John R. Viegas, and Yvonne S. Sheaffer Washington, NASA, June 1963 40 p 18 refs
(NASA TN D-1885) OTS: $1.00

Chemical-reaction rate coefficients for the dissociation of CO_2 and CO are estimated by use of collision theory and are compared with experimental results obtained at low temperatures. The effect of varying the number of square terms of energy effective in collisions on the rate coefficients is examined. The estimated rate coefficients are employed to study the interdependent chemical-rate processes for the dissociation of CO_2 and its components (including five chemical species) coupled with the fluid flow behind a normal shock wave. Solutions of the differential equations are obtained for shock speeds up to 10 km/sec at 10^2 to 10^{-4} standard atmospheric density by three methods. Thus, results of two simplified methods (one of which leads to a closed-form solution) are compared with those of an exact method. Chemical relaxation effects for shock waves in CO_2 are compared with those in N_2 and O_2. Results for CO_2 are presented in the form of flowfield profiles of pressure, temperature, density, enthalpy, and species concentration, and in the form of a relaxation distance behind the shock as a function of shock speed and ambient density. Author

N63-17546 Radiation Applications, Inc., Long Island City, N.Y.

A STUDY OF THE MECHANISM OF RADIATION-INDUCED GELATION IN MONOMER-POLYMER MIXTURES **Quarterly Summary Report, Feb. 2–Apr. 30, 1963**

May 3, 1963 34 p 10 refs
(Contract AT(30-1)-2816)
(RAI-320)

Cellulose acetate containing allyl acrylate or methacrylate exhibits 95% to 100% gel over the 5 to 50 Mrad range, and the gel content then drops upon further irradiation. Monomer-free systems show no gel at all, and degrade upon irradiation. The acid hydrolytic stability of cellulose acetate-divinyl benzene (or styrene) irradiated systems is improved over that of the plasticizer-free cellulose acetate. The tensile strength of polyethylene-4 1/2% allyl methacrylate at 115° C, above the polymer's normal T_m, is higher than the monomer-free system over the entire dose range tested, to 240 Mrads. Polyethylene-0.3% diallyl maleate is intermediate between the monomer-free and AMA system, not only for gel behavior, but also for tensile behavior. Polyethylene and polypropylene have been cross-linked, employing a mutual irradiation in the presence of solvent plus polyfunctional monomer. The process has been extended to film and fiber. Author

N63-17548 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

INVESTIGATION OF CATALYST BEDS FOR 98-PERCENT-CONCENTRATION HYDROGEN PEROXIDE

Jack F. Runckel, Conrad M. Willis, and Leland B. Salters, Jr. Washington, NASA, June 1963 80 p 19 refs
(NASA TN D-1808) OTS: $2.00

An investigation of the effect of variation in screen composition and arrangement on the performance of 90- and 98-percent-concentration hydrogen peroxide catalyst beds has been made. Conventional catalyst beds with certain modifications were found to be suitable for use with 98-percent-concentration hydrogen peroxide. Up to 25 silver screens were used without excessive melting of silver, provided they were located at the upstream end of the bed. The use of 40-mesh silver screens afforded better starting response characteristics than 20-mesh screens. The use of 2-percent-concentration samarium nitrate, in lieu of 10 percent, was found to be adequate for treatment of silver screens under certain conditions. Bed life was sufficient for reaction-control-rocket missions. The tests covered environmental temperatures from 35° F to 82° F and a chamber pressure range from 100 to 315 pounds per square inch absolute. Author

N63-17564 Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge

FERROELECTRICITY AND THE CHEMICAL BOND IN PEROVSKITE-TYPE OXIDES

Carl W. Nelson May 1963 34 p 43 refs
(Contracts AF 19(604)-6155 and AF 33(616)-8353)
(MIT-TR-179)

The role played by the cuboctahedral-coordinated cation is described. Comparison of the environment of a cation in acid solution and in perovskite-type oxides reveals great similarity of bonding. By application of group-theoretical methods, a symmetry classification of orbitals is derived for each molecular point group occurring in $BaTiO_3$. Molecular-orbital energy-level diagrams are constructed. The number and classification of the electronic transitions are predicted by means of the selection rules. It is shown that only ions with empty d shells are capable of forming ferro- and antiferroelectric perovskite-type oxides. A discussion of conductivity in these materials is given. Author

N63-17603 Hercules Powder Co., Wilmington, Del.
A STUDY OF THE ELECTRONIC CONFIGURATION AND BEHAVIOR OF THE $-NF_2$ GROUP Quarterly Report No. 1, Mar.-May 1963
A. A. Albert et al June 15, 1963 46 p 21 refs
(Contract DA-31-124-ARO(D)-62; ARPA Order 402, Task 2)

This program aims an integrated physical-chemical study at a more complete understanding of the electronic configuration and the behavior of the $-NF_2$ group. The relative probability of existence and the stability of NF_2 ions and radicals in various environments and under diverse conditions are being defined by four complementary studies of simple NF_2 compounds: (a) electrochemical investigations, (b) complex formation studies, (c) NMR-ESR studies, and (d) theoretical calculations. Author

N63-17615 Minnesota U., Minneapolis
NON-RADIATIVE ELECTRONIC ENERGY TRANSFER IN ORGANIC LIQUIDS AT HIGH "DONOR" CONCENTRATIONS Final Report
Sanford Lipsky May 1963 35 p 47 refs Part of this report, "Scintillation Properties of Liquids," presented at Intern. Symp. on Physical Processes in Radiation Biology, May 5-8, 1963
(Contract AF 19(604)-8356)
(AFCRL-63-610)

The efficiency of electronic energy transfer from the liquids benzene, toluene, p-xylene and mesitylene to p-terphenyl was determined both for ultraviolet excitation in the first absorption band and for Cs^{137} gamma excitation. In addition, the efficiency with which oxygen quenches the transport process was determined for both modes of excitation. Both energy transfer and oxygen-quenching constants are larger than would be predicted on the basis of a diffusion limited rate. Dilution of the aromatic liquids with hexane is found to significantly reduce the rate of energy transfer. The participation of the bulk solvent in these processes seems to be implicated. Mechanisms of energy transfer utilizing the states of the bulk solvent are briefly reviewed. The relative scintillation efficiencies were determined for solutions of p-terphenyl in benzene, toluene, p-xylene and mesitylene and compared with values approximately calculated from the optical transitión probabilities and the efficiencies of internal conversion from upper electronic states to the transferring state—the first excited singlet. The construction of the fluorimeter is described and the emission spectrum of pure liquid benzene is presented. Author

N63-17648 Aerospace Medical Div. Arctic Aeromedical Lab., Fort Wainwright, Alaska
EFFECTS OF COLD ACCLIMATIZATION ON LIVER DI- AND TRIPHOSPHOPYRIDINE NUCLEOTIDE
John P. Hannon and Arthur Rosenthal Jan. 1963 10 p 15 refs
(AAL-TDR-62-40)

The levels of oxidized and reduced di- and triphosphopyridine nucleotide were measured in liver tissue from rats that had been exposed to cold (4° ±1° C) for one month. These animals exhibited about 65% more TPNH and total triphosphopyridine nucleotide than control animals maintained at an ambient temperature of 25° ±1° C. The significance of these alterations to the efficiency of oxidative phosphorylation is discussed. Author

N63-17652 Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.
ORGANIZED ELEMENT: POSSIBLE IDENTIFICATION IN ORGUEIL METEORITE
Frank W. Fitch and Edward Anders Repr. from Science, v. 140, no. 3571, June 7, 1963 p 1097-1100 10 refs
(NASA Grant NsG-366)

Ragweed pollen stained by the Gridley method becomes distorted so that it resembles Claus and Nagy's Type 5 organized element, a particle found in a Gridley-stained preparation of the Orgueil carbonaceous chondrite. Author

N63-17691 Harvard U. Mallinckrodt Chemical Lab., Cambridge
RELATIVE INTENSITY MEASUREMENTS IN MICROWAVE SPECTROSCOPY
Alan E. Esbitt and E. Bright Wilson, Jr. [1963] 28 p 23 refs
(Supported by ONR)

A method is described for the measurement of peak intensity ratios of gas-phase microwave-absorption lines. Large errors associated with multiple reflections in the waveguide have been eliminated by careful design and the use of ferrite isolators. Detector nonlinearities have been neutralized by using a precisely calibrated step attenuator that allows both lines involved in a ratio to be displayed with approximately the same amplitude. Means of minimizing additional sources of error are discussed. Application of the method to a number of problems indicates that ratios accurate to a few percent can be obtained. Author

N63-17705 California U., Berkeley. Lawrence Radiation Lab.
INORGANIC MATERIALS RESEARCH DIVISION ANNUAL REPORT, 1962
Leo Brewer and Alan W. Searcy Feb. 28, 1963 235 p refs
(Contract W-7405-eng-48)
(UCRL-10706) OTS: $3.00

This summary report is organized into three main sections, Chemistry, Metallurgy and Ceramics, and Reactor Materials Engineering. Each of the sections is further divided into a number of research areas. The work of each investigator has been grouped, in general, under the most appropriate single heading in order to give a view of the breadth of the research interest of each principal investigator. Author

N63-17714 Bureau of Mines. College Park Metallurgy Research Center, Md.
STUDIES ON THE SPECTROCHEMICAL ANALYSIS OF SOLUTIONS: USE OF CARRIER-PRECIPITATION AND A FILTER ELECTRODE
C. L. Chaney and M. J. Peterson 1963 22 p 16 refs Presented in part before Conf. on Analytical Chemistry and Applied Spectroscopy, Pittsburgh, Mar. 1962
(BM-RI-6249)

Investigations were conducted to develop spectrochemical methods capable of determining 0.01 to 100 micrograms of metals in 50 milliliters of solution. The use of gallium hydroxide ($Ga(OH)_3$) as a carrier-precipitant to concentrate metallic ions is described. A porous-cup graphite electrode is used to collect the precipitate. A specially designed plunger permits the electrode assembly to serve as the sample-containing electrode in the subsequent spectrographic analysis. Analytical curves are presented for antimony, arsenic, beryllium, and zinc. Sensitivities of detection are given for 13 elements. The techniques were applied to identify impurities separated from tungsten, to determine trace impurities in solutions containing high concentrations of magnesium, cobalt, or nickel, and to identify trace impurities in hydrofluoric acid. Laboratory glassware was a serious source of contamination when low levels of zinc were determined. Author

N63-17717 Massachusetts U. Polymer Research Inst. Amherst, Mass.
X-RAY STUDIES OF POLYBUTENE-1, POLYPENTENE-1, AND POLYHEXENE-1

Sadao Hoshino and Joseph Powers Sept. 20, 1962 23 p 7 refs
(Contract Nonr 3357(01))
(ONR-TR-52)

The effect of mechanical and thermal treatment on the X-ray diffraction patterns of polybutene-1, polypentene-1, and polyhexene-1 is examined. These variables are found to influence the transformation among polymorphic forms of these polymers. Author

N63-17723 California U., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology

PROJECT SEDAN. PART I. CHARACTERISTICS OF FALL-OUT FROM A DEEPLY BURIED NUCLEAR DETONATION FROM ABOUT 3 TO 150 MILES FROM GROUND ZERO. PART II. AERIAL RADIOMETRIC SURVEY Preliminary Report

K. H. Larson, B. W. Kowalewsky, R. A. Wood, H. M. Mork, D. Paglia, and R. B. Guillou Aug. 1962 65 p 18 refs
(PNE-225P) OTS: $1.50

The objectives of CETO Project 62.86 were to determine the physical and radiological characteristics of fallout from the detonation of a nuclear device buried in desert alluvium at 635 feet below ground surface. The fallout collections were made from less than 3 miles to about 100 miles from ground zero. These objectives were satisfactorily met by fallout collections obtained from 74 of the 92 stations established. Samples have been processed with respect to size fractions, and data are being evaluated. The primary objective of CETO Project 62.80, Aerial Radiometric Surveys, to determine the areal distribution of SEDAN fallout deposited on the ground from 10 to 200 miles from ground zero, was accomplished. The fallout pattern is shown by the dose rate contours to be asymmetric with a steep gradient west of the midline with a very gradual gradient on the east. Gamma energy spectral measurements made at 100 feet above the ground surface resulted in the tentative identification of the radionuclides I^{131}, Te^{132}, I^{132}, W^{187}, and $Ba^{140}-La^{140}$. Author

N63-17725 Harvard U. Mallinckrodt Chemical Lab., Cambridge, Mass.

MICROWAVE AND MASS SPECTRA OF S_2F_2

E. Bright Wilson, Jr. and Robert L. Kuczkowski [1962] 7 p 11 refs
(Sponsored by ONR)

Sulfur monofluoride has been successfully prepared and identified by its mass and microwave spectra. One gram of argentous fluoride (AgF) and six grams of sulfur were mixed and slowly heated *in vacuo* in glass to the melting point of sulfur. The gases produced were condensed with liquid nitrogen. Microwave absorption lines were observed due to SO_2 and SOF_2, as well as additional lines. The mass spectrum indicated SiF_4, SO_2, and SOF_2, as well as peaks at 83 and 102 m/e units. The mass spectrum analysis led to the tentative conclusion that the new microwave lines were due to sulfur monofluoride. The basis for this assertion is: (1) the intensity of the lines correlate with the lines obtained from different samples with different purification steps; (2) the structure obtained by assuming the empirical composition S_2F_2 is almost identical with that predicted from the known structure, SOF_2; (3) the microwave data and the moments of inertia obtained therefrom are only reasonable for S_2F_2. D.E.R.

N63-17730 California U., Berkeley

SINGULAR PERTURBATION REFINEMENT TO QUASI-STEADY STATE APPROXIMATION IN CHEMICAL KINETICS

A. Acrivos (Stanford U.), A. K. Oppenheim, and J. R. Bowen (Cambridge U.) Repr. from Chem. Eng. Sci., v. 18, 1963 p 177–188 15 refs
(NASA Grant NsG-10-59)
(NASA CR-50226)

It is shown that the well-known quasi steady-state approximation of chemical reaction kinetics can be refined in a rigorous manner by the use of a powerful mathematical technique known as the method of singular perturbations. For the purpose of bringing out the essential features of this technique, four typical kinetic schemes are analyzed, namely, those of reactions: $R \rightarrow I \rightarrow P$; $R \leftrightarrows I \leftrightarrows P$; $R \rightarrow I$; $21 \leftrightarrows P$; and $R + M \leftrightarrows I + P + M$; $R + I \rightarrow P$; the latter corresponding to the case of thermal decomposition of ozone. Author

N63-17837 Monsanto Research Corp., Dayton, Ohio

PARTIALLY FLUORINATED POLYAROMATIC ETHERS: SYNTHESIS, THERMAL STABILITY AND OTHER PHYSICAL PROPERTIES

G. A. Richardson and E. S. Blake 1963 11 p 4 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session V-A, San Antonio, Tex., Apr. 16–19

Fluorinated aromatic ethers are being studied for possible use as base stocks for fire-resistant high-temperature hydraulic fluids. Such molecules seem ideal because of their strong chemical bonds and free rotation about the oxygen atom, which should contribute to improved viscosity properties. Also, all hydrogen is replaced with the halogen, which should stabilize the molecule oxidatively and render it fire resistant. Attempts to synthesize decafluorodiphenyl ether by the reaction of potassium pentafluorophenoxide and hexafluorbenzene in polar solvents have given poor yields (20%) and have been proven impractical. But the synthesis of a number of selected partially fluorinated polyphenyl ethers gives valuable information on the synthesis of perfluoro-ethers as well as establishing thermal stability levels and other physical properties, e.g., flammability and viscosity, of the compounds. It is found that perfluorinated polyphenyl ethers are thermally less stable than their hydrogen analogs by about 165° F, that partial fluorination, to 31%, does not increase the autoignition temperature, and that the viscosity properties of halogenated polyphenyl ethers render them unsuitable for application as hydraulic fluids. D.E.R.

N63-17842 Dynamic Science Corp., South Pasadena, Calif.

BORON NITRIDE GREASES

M. Gerstein [1963] 14 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session IV-A, San Antonio, Tex., Apr. 16–19

Experimental conditions for obtaining a particulate solid of extremely uniform dimensions and of submicron size from the ammonia-boron trichloride reaction have been determined, and gram quantities of several samples have been prepared. The solid obtained at a reaction temperature of 450° C appears to be an intermediate amide or imide of boron rather than pure boron nitride. Author

N63-17871 Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson AFB, Ohio

HIGH TEMPERATURE FLUID SYNTHESIS

G. Baum and C. Tamborski [1963] 7 p 9 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VI-B, San Antonio, Tex., Apr. 16–19

Synthetic fluid structures of greater stability than the structurally altered esters and polyphenyl ethers are being investigated. Emphasis is placed on two major units of these structures; a stable nucleus on which the second unit, pendent groups, may be placed. The nucleus governs the thermal and chemical stability of the fluid while the pendent group provides molecular flexibility and asymmetry, and imparts good low-temperature properties. Triphenyl triazine, dialkyl pyrazines, and cyclic phosphonitric chloride trimers are discussed; these compounds possess a favorable combination of stability and physical properties. C.L.W.

N63-17885 Bureau of Mines, Washington, D.C.

LOW-TEMPERATURE HEAT CAPACITY AND ENTROPY AT 298.15° K OF RED MERCURIC SULFIDE

E. G. King and W. W. Weller 1962 8 p refs
(BM-RI-6001)

This paper reports Bureau of Mines measurements of the low-temperature heat capacity of red mercuric sulfide (cinnabar), and the entropy value at 298.15° K derived therefrom. The entropy value was combined with heat data to obtain free-energy values for the formation of red mercuric sulfide from liquid or gaseous mercury and from rhombic or gaseous diatomic sulfur. Author

N63-17886 Bureau of Mines, Washington, D.C.

PRODUCTION OF MOLYBDENUM METAL BY MAGNESIUM REDUCTION OF MOLYBDENUM OXIDES

T. T. Campbell, F. E. Block, and E. R. Andersen 1962 27 p 7 refs
(BM-RI-5934)

Molybdenum trioxide (MoO_3) and mixtures of molybdenum dioxide (MoO_2) and trioxide were reduced by magnesium in closed steel bomb reactors. Very high pressures in excess of 5,000 psi developed during magnesium reductions of MoO_3. The addition of calcium oxide to the bomb charges caused a significant reduction in pressure. Reaction efficiencies higher than 95 percent were obtained during magnesium reductions of either MoO_3 or mixtures of MoO_2 and MoO_3, but high pressures were encountered when the charges contained from 30 to 60 percent MoO_2. Reaction efficiencies were usually low (less than 80 percent) when the bomb charges contained more than 40 percent MoO_2. The charges with the best composition, considering operating pressure, yield, and purity, contained from 10 to 30 percent MoO_2. The addition of small amounts of carbon to the reaction charges was helpful because some deoxidation occurred during the reduction and also during subsequent arc-melting of the regulus metal. The purity of the bomb-reduced, arc-cast molybdenum metal ranged from 99.2 to 99.8 percent, and in some instances the metal contained as little as 5 parts per million oxygen. The regulus metal can be collected as a cast ingot in the bomb. These rough ingots were joined into consumable electrodes that were subsequently arc-melted into sound arc-cast ingots. The ductility of the arc-cast, bomb-reduced metal was determined by fabrication tests. Ingot sections were impact forged through reductions of over 50 percent. Workability of the metal could not be correlated with chemical analyses or hardness data; however, large amounts of carbon and oxygen did harden and embrittle the metal. Author

N63-17887 Bureau of Mines, Washington, D.C.

PREPARATION OF COLUMBIUM AND TANTALUM BY METALLIC REDUCTION OF THEIR CHLORIDES

T. T. Campbell, F. E. Block, G. B. Robidart, and J. L. Schaller 1962 24 p 12 refs
(BM-RI-6080)

Research demonstrated the feasibility of preparing columbium and tantalum metals by the application of Kroll-process techniques. Yields in excess of 95 percent were obtained in a modified Kroll-process reduction apparatus constructed from nickel and Inconel. Operating conditions during reduction and distillation were determined. Calculations based on the results obtained in small-scale tests indicate that reaction rates of up to 34 lb/hr could be obtained during columbium reductions, and up to 60 lb/hr during tantalum reductions in production scale reactors. Analyses of arc-melted buttons prepared from Kroll-process tantalum or columbium showed that tantalum of greater than 99.8-percent purity was obtained, and that columbium purity exceeded 99.7 percent. A significant purification of the reduced metals occurred when they were consolidated by electron-beam melting, and the purity and ductility of electron-beam-melted Kroll-process tantalum and columbium compared favorably with the commercial metals. After electron-beam melting, the purity of the tantalum exceeded 99.95 percent, and columbium purity was approximately 99.9 percent. Author

N63-17889 Bureau of Mines, Washington, D.C.

HEATS AND FREE ENERGIES OF FORMATION OF ANTIMONY SESQUIOXIDE AND TETROXIDE

Alla D. Mah 1962 9 p refs
(BM-RI-5972)

This paper supplies heat and free-energy-of-formation values at 298.15° K for the sesquioxide and tetroxide, based upon new measurements conducted by the Bureau of Mines. The heats of formation were obtained by combustion (bomb) calorimetry, and the free energies of formation were obtained by combination of heat and entropy data. The new values are believed to substantially improve the accuracy of thermodynamic considerations involving these oxides. Author

N63-17890 Bureau of Mines, Washington, D.C.

HIGH-TEMPERATURE HEAT CONTENTS AND ENTROPIES OF ZIRCONIUM FLUORIDE AND ZIRCONIUM SULFATE

D. F. Smith, W. C. Miller, and A. R. Taylor, Jr. 1962 7 p refs
Work done in cooperation with the U. of Ala.
(BM-RI-5964)

The thermodynamic data presented in the literature for zirconium compounds are incomplete. Among the compounds for which adequate data are lacking are zirconium fluoride and sulfate. This paper reports experimental heat-content values determined for these two zirconium salts throughout the temperature range of 273° to 1,200° K. No crystalline transformations were found in the two compounds investigated, and neither of the compounds melted over the temperature range studied. Author

N63-17905 Boston U., Mass.

CRYSTAL STRUCTURE STUDIES OF MATERIALS FOR POTENTIAL USE IN SOLAR ENERGY CONVERSION

Klaas Eriks Apr. 30, 1963 13 p 10 refs
(Contract AF 19(604)-5995)
(AFCRL-63-606)

This report describes X-ray structural studies of six different substances: Aluminum dodecaboride, AlB_{12}; ammonium 12-tungstocobalto-cobaltiate, $(NH_4)_7\ [Co^{+2}Co^{+3}W_{12}O_{42}]$; pyridine-boron trichloride, $C_5H_5N.BCl_3$; trimethylphosphine borane, $(H_3O)_3P.BH_3$; pararosanilin perchlorate, $(H_2NC_6H_4)_3C.ClO_4$; cobaltous chloride-dimethylsulfoxide, $CoCl_2\ [(CH_3)_2SO]_3$. Author

N63-17916 National Lead Co. of Ohio, Cincinnati

REMOVAL OF FOREIGN ORGANIC MATERIALS FROM TBP-KEROSENE SOLVENT

N. R. Leist and J. H. Krekeler et al June 25, 1963 29 p 18 refs
(Contract AT(30-1)-1156)
(NLCO-882) OTS: $0.75

Three major sources of organic contamination of the tri-n-butyl (TBP)-kerosene solvent have been identified. Two of these "tramp" materials, lubricating oils used in the extraction system and organic materials present in the incoming feed concentrates, can build up rapidly in the TBP-kerosene system and quickly render the solvent unsuitable for uranium extraction in the pulse column system. The third source of contamination was the nitration of the kerosene in the solvent. These foreign organic materials can be detected qualitatively, and, to some extent, quantitatively through coalescence time testing and a light-transmittance test of the solvent. A nitric acid saturation–charcoal adsorption treatment was developed to remove these "tramp" materials from the TBP-kerosene solvent and rehabilitate the solvent for uranium-extraction purposes. A plant solvent-treatment-system process was designed and installed. Author

N63-17940 Université Libre de Bruxelles, Brussels (Belgium)

VAPORIZATION OF COMPOUNDS AND ALLOYS AT HIGH TEMPERATURES. PART X. THE DISSOCIATION ENERGY OF THE GROUP IV—GROUP VI MOLECULES

R. Colin and J. Drowart Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, May 1963 37 p 62 refs
(Contract AF 61(052)-225)
(WADD-TR-60-782, Pt. X)

The available spectroscopic and thermochemical data for the dissociation energy of the group IV–group VI MeX molecules are reviewed, and the best present values proposed. Correlations of several excited molecular states with atomic products are proposed. Author

N63-17959 Aktiebolaget Atomenergi. Nuclear Chemistry Lab., Stockholm (Sweden)

ANION-EXCHANGE STUDIES OF RADIOACTIVE TRACE ELEMENTS IN SULPHURIC ACID SOLUTIONS

K. Samsahl 1963 14 p 6 refs
(AE-103)

As part of a chemical group separation procedure used as a pretreatment in gamma spectrometric analysis, a study has been made of the adsorption from sulphuric acid solutions on strongly basic anion exchange resins, prepared in the hydroxide and the sulphate forms, of trace activities of Na, P, K, Ca, Sc, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Rb, Sr, Zr, Nb, Mo, Tc, Ag, Cd, In, Cs, Ba, La, Ce, Hf, Ta, W, Ir, Pa, and Np. Besides adsorbing some of the trace elements in the solution, the anion-exchange resin in the hydroxide form will neutralize the bulk of the sulphuric acid. This makes possible the subsequent sequential separation of chloride complexes on short anion-exchange columns by a stepwise increasing of the HCl concentration of the solution. On the basis of the results obtained in the present and earlier experiments, a new improved chemical group-separation procedure for mixtures of radioactive trace elements is outlined. Author

N63-17976 St. Joseph Coll., West Hartford, Conn.

FORMATION OF ENERGY RICH COMPOUNDS AT LIGHT ACTIVATED SENSITIZER SURFACES Final Report

Maria Clare Markham June 1963 83 p 46 refs
(Contract AF 19(604)-7224)
(AFCRL-63-608)

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N63-17977 St. Joseph Coll., West Hartford, Conn.

CONVERSION OF ISOPROPYL ALCOHOL TO ACETONE ON IRRADIATED ZINC OXIDE

Joseph C. Kuriacose and Maria Clare Markham *In its* Formation of Energy Rich Compounds at Light Activated Sensitizer Surfaces June 1963 Repr. from J. Catalysis, v. 1, no. 6, Dec. 1962 p 498–507 32 refs Presented in part before Div. of Phys. Chem., 141st Meeting of the Amer. Chem. Soc., Wash., D.C., Mar. 20–29, 1962 (See N63-17976 16-07)
(Contract AF 19(604)-7224)

Irradiated suspensions of zinc oxide containing isopropyl alcohol form acetone and peroxide, provided an adequate concentration of oxygen is present. Initial quantum yields of these products range from 0.25 to 1.50, depending on concentration of alcohol, specific catalyst surface, light intensity, and temperature. The peroxide concentration reaches a limiting value under all conditions, but the acetone accumulates indefinitely. Detailed investigation shows that the products obtained are the result of reactions of radicals in the liquid phase, as well as direct surface reactions. The former are particularly important in pure organic liquids. The data obtained are best explained on the assumption that the energy of radiation at 3650 Å, approximately 80 kcal absorbed by zinc oxide, gives rise to an active form of oxygen which initiates both the surface and liquid-phase reactions. Consideration of the various possible reactive forms of oxygen which might be produced under these conditions leads to the conclusion that an excited molecular oxygen anion is the most probable active intermediate. This interpretation is consistent with observations on irradiated zinc oxide reported by other investigators and also by previous studies carried out in this laboratory. Author

N63-17978 St. Joseph Coll., West Hartford, Conn.

MECHANISM OF THE PHOTO-INITIATED POLYMERIZATION OF METHYL METHACRYLATE AT ZINC OXIDE SURFACES

Joseph C. Kuriacose and Maria Clare Markham *In its* Formation of Energy Rich Compounds at Light Activated Sensitizer Surfaces June 1963 Repr. from J. Phys. Chem., v. 65, 1961 p 2232–2236 7 refs (See N63-17976 16-07)
(Contract AF 19(604)-7224)

Detailed investigation of the photosensitized polymerization of methyl methacrylate in suspensions of zinc oxide in various solvents, irradiated by near ultraviolet light at 365 mμ, demonstrates conclusively that surface-adsorbed oxygen is essential to chain initiation. Polymers of high molecular weight, *ca.* 10^6, are obtained with oxygen-free solutions, and untreated zinc oxide surfaces. Zinc oxide reduced under hydrogen, or heated to remove surface oxygen during evacuation, results in greatly suppressed polymerization. Presence of oxygen in solution yields a larger number of chains initiated, but lower molecular weight. Excess oxygen inhibits polymerization completely. Comparison of polymerizations in various solvents indicates that solvents having high dielectric constants coupled with good proton-donating or hydrogen-bonding characteristics favor chain initiation *via* excited oxygen on the surface. This photoactivated oxygen is formed on the surface of zinc oxide during irradiation, and the polymer chains initiated by it continue to grow for some time in the dark. Evidence that the excited oxygen may be an anion initiator stems from the observation that methyl methacrylate and acrylonitrile polymerize readily in these systems, but styrene does not polymerize at all. Electron-spin-resonance spectra show that both oxygen and water adsorbed in the dark are able to trap all the conduction electrons in heated, evacuated zinc oxide, but light is necessary for initiation of polymerization. Ultraviolet light at 365 mμ therefore is believed to produce an excited oxygen, probably anion radical, at the surface of the zinc oxide. Author

N63-17979 St. Joseph Coll., West Hartford, Conn.

EFFECTS OF AMIDES ON PHOTOCHEMICAL PROCESSES AT ZINC OXIDE SURFACES

Maria Clare Markham, Joseph C. Kuriacose, Joann De Marco, and Carol Giaquinto *In its* Formation of Energy Rich Compounds at Light Activated Sensitizer Surfaces June 1963 Repr. from J. Phys. Chem., v. 66, 1962 p 932–936 8 refs (See N63-17976 16-07)
(Contract AF 19(604)-7224)

Amide residues exert a stabilizing influence on hydrogen peroxide at irradiated surfaces of zinc oxide in aqueous suspension, whether the peroxide has been formed in the system by the photocatalyzed oxidation of the amide itself, or whether hydrogen peroxide has been added to the system before irradiation. In the former case, the rate of oxygen uptake and the final steady-state concentration of hydrogen peroxide are related to the number of oxidizable C-H bonds in the amide. In the latter case, the level of hydrogen peroxide that can be maintained is governed by both the initial concentration of added peroxide and the nature of the amide. Formamide gives rise to a surface-inactivating residue immediately on irradiation in contact with zinc oxide, and therefore stabilizes high concentrations of added peroxide, but produces very little peroxide itself. Acetanilide both produces and maintains high concentrations of hydrogen peroxide. Other amides studied include N-methylformamide, N,N-dimethylformamide, and urea. Effects of several nitrogen-containing compounds are compared with those of the amides. Author

N63-17980 St. Joseph Coll., West Hartford, Conn.

INFRARED STUDIES OF NITROGENOUS RESIDUES AND THEIR EFFECTS ON PHOTOCATALYTIC PROPERTIES OF ZINC OXIDE

In its Formation of Energy Rich Compounds at Light Activated Sensitizer Surfaces June 1963 p 6–17 5 refs (See N63-17976 16-07)

Pretreated zinc oxide catalysts were studied by infrared absorption spectroscopy so as to identify the nature of the electron-deficient nitrogen-containing species that remained adsorbed on the zinc oxide surfaces and to investigate the mechanism of the photocatalytic formation and decomposition of hydrogen peroxide by zinc oxide in the presence of amides and other simple nitrogen-containing compounds. It was found that formamide and the cyanides are effective in inhibiting the decomposition of hydrogen peroxide in these systems, that the cyanate ion is readily adsorbed on zinc oxide surfaces but does not have a noticeable effect on peroxide decomposition, and that a loss of electrons concurrent with adsorption in the presence of oxygen is the mechanism of adsorption for the cyanide and formamide ions. D.E.R.

N63-17981 St. Joseph Coll., West Hartford, Conn.

PHOTOELECTRIC EFFECTS AT ZINC OXIDE ELECTRODES

In its Formation of Energy Rich Compounds at Light Activated Sensitizer Surfaces June 1963 p 18–28 9 refs (See N63-17976 16-07)

The efficiency of electron transfer processes at irradiated zinc oxide surfaces suggests that electrical work can be derived from photoelectric cells containing zinc oxide electrodes. Photo emf's higher than any previously reported can be obtained by proper selection of the dark half-cell, and use of doped zinc oxides offers promise of producing even higher currents. Use of formamide to maintain a continuous supply of electrons and complex cobalt ions as the reduction half-cell offers possible effective cell combinations. The problems of evaluating the efficiency of such cells are that: (1) measurements of the quantum yields of zinc oxide systems below 365 mμ are scanty, with best results of the order of 10% to 20% ergs compared to 100% ergs of energy at 365 mμ falling on the electrode; relative values for the ergs are $cm^{-2}sec^{-1}$; (2) there is a 10% drop in photocurrent and voltage for 100 hours continuous running time with the cells due to the agar bridge admitting p-quinone and causing channeling; (3) the irradiated zinc oxide electrode has a very high resistance, causing difficulty if efficient conversion of light energy to work is desired. D.E.R.

N63-17982 St. Joseph Coll., West Hartford, Conn.

STUDIES OF ENERGY TRANSFER BETWEEN PHEOPHYTIN AND CAROTENE IN RED LIGHT

In its Formation of Energy Rich Compounds at Light Activated Sensitizer Surfaces June 1963 p 29–37 8 refs (See N63-17976 16-07)

Beta-carotene has been irradiated with red light in the presence of pheophytin, but the identification of the reaction product is only circumstantial. It appears that the carotene is reduced, and the reaction is photosensitive. Hydrogen appears, but may come from the solvent or from the phytol side chain of the pheophytin. There is evidence that the porphyrin ring of the pheophytin does not change. The reduction process is undetermined as to its number of steps and reversibility. The solvent appears to be important, because the reaction proceeds about four times faster in methanol than in hexane. On elution of the product with methanol and ultraviolet spectrum analysis, the product is found to be related to the quinones containing carotenoid side chains, such as ubiquinone, plastoquinone, and Q-254. D.E.R.

N63-18014 Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho

ANNUAL REPORT OF DIVISION ANALYTICAL BRANCH FOR 1962

Ralph C. Shank AEC Natl. Reactor Testing Station, Apr. 25, 1963 166 p refs
(Contract AT(10-1)-205)
(IDO-14605) OTS: $2.75

A total of 71,378 determinations was made by the Analytical Branch with an average force of 42.8 persons. With the main plant being down a large portion of the year, only 11% of Analytical productive time was required to service it; however, an additional 7% was required by the Demonstrational Waste Calciner Facility (DWCF) operation. Budgeted analytical development and burnup programs required 23%, and work from outside ICPP required 30%, of the time. The remaining 29% was used by ICPP Technical Branch. Author

N63-18073 Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Md.

PROCESS DEVELOPMENT QUARTERLY PROGRESS REPORT, JANUARY-MARCH 1963

J. H. Yeager et al May 1, 1963 28 p 18 refs
(Contract W-14-108-eng-8)
(MCW-1480) OTS: $0.50

A spectrochemical method has been developed for the determination of boron in high-purity magnesium metal. The method is based on a carrier-distillation technique using copper fluoride as the carrier. Of sixteen compounds investigated as a carrier, copper fluoride was found to be the most suitable, and optimum conditions were established. The method is calibrated for the analytical range between 0.2 and 3.0 ppm boron. Precision at 0.3 ppm is ±0.05 ppm at the 95% confidence level. Several cell designs have been developed which will yield good-quality uranium metal from uranium oxides fed directly to the cell. Cell throughput was found to increase with increased UF_4 concentration in the electrolyte. Electron-microprobe analysis was conducted for aluminum and silicon concentration gradients across the bond layer of a type-OIIIN core and its aluminum-silicon braze. Both X-ray emission and electron backscatter were used for the quantitative analysis of the bonds. A compound of uranium and silicon (probably USi_2) is indicated for the smooth or "brittle" bond. The jagged, strong bond is an aluminum–uranium system of varying concentrations.
Author

N63-18101 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

ANALYSES OF THE CHEMICAL REGENERATION OF SUBLIMATING THERMIONIC COMPONENTS

L. K. Tower Repr. from Advanced Energy Conversion, Pergamon Press (Gt. Brit.), v. 3, 1963 p 185–198 8 refs

This paper discusses the process of chemical regeneration of hot metallic surfaces, which may find application in very high temperature thermionic devices. An analysis is made of chemical regeneration under conditions of free molecule flow (Knudsen conditions) in which particles are assumed not to interact in the interspace. Partial or complete equilibration is assumed at the walls, the degree of equilibration being expressed by a recombination coefficient, γ. The analysis prescribes conditions within the system required to prevent destruction of the surfaces. A simplification of the analysis yields a thermodynamic criterion for selection of materials to be tested in regenerative systems. Some hypothetical systems are considered as examples. These are: tungsten–chlorine, molybdenum–chlorine, tungsten–molybdenum–chlorine, and tungsten–oxygen. The possible difficulty in constructing a stable device with an emitter and collector of the same material is discussed, together with a solution to the problem.
Author

N63-18103 Texaco Experiment Inc., Richmond, Va.

INVESTIGATION OF THE DISSOCIATION CHEMISTRY OF $-NF_2$ COMPOUNDS Quarterly Summary Report, Feb.-Apr. 1963

U. V. Henderson, Jr., and P. L. Goodfriend May 1, 1963 13 p 4 refs
(Contract Nonr-1883(00))
(EXP-223; TM-1423)

Dissociation experiments have been carried out by both thermal and photolytic means. No meaningful thermal-dissociation data have been obtained with the adiabatic-compression apparatus; however, the apparatus appears to be operating properly. Preliminary flash photolysis experiments on NF_3 sensitized by NO indicated no dissociation by light of wavelength greater than 2200 A. Some N_2F_4 experiments are reported which indicate a flash-induced formation of NF_2 that reaches a maximum about 200 μsec after the photolysis flash. A study of the NF_2 spectra in the region of 2600 A has revealed a previously unreported band structure superimposed on a continuous background. The flash-photolysis cell has been modified to include a concentric flash source around a high-purity quartz cell, which permits photolysis with radiation down to 1700 A or sensitization of the photodissociation by oxygen.
Author

N63-18113 California U. Los Alamos Scientific Lab. New Mexico

THE TITRIMETRIC DETERMINATION OF TRACES OF NITRIDE NITROGEN IN SODIUM METAL

C. H. Ward, R. D. Gardner, W. H. Ashley, and A. Zerwekh June 3, 1963 13 p 4 refs
(Contract W-7405-eng-36)
(LA-2892) OTS: $0.50

A modified Kjeldahl method has been shown to be applicable to the determination of nitride nitrogen in sodium metal. The sodium is dissolved in ethanol in an argon atmosphere. The solution is diluted with water, and the nitrogen distilled out as ammonia. The ammonia is absorbed in a dilute boric acid solution and titrated with 0.01N hydrochloric acid to the endpoint of a mixed methyl red-bromcresol green indicator. The average recovery for 31 samples containing known amounts of nitrogen in the 1 to 100 p.p.m. range was 100.0%. The average standard deviation over the entire range was 2.5% relative. This number increases rapidly in the lower part of the range. In absolute terms, it was less than 1 p.p.m. over the whole range.
Author

N63-18114 California U. Los Alamos Scientific Lab. New Mexico

GRAPHITE-HYDROGEN-METHANE KINETICS ABOVE 1600° K

John D. Rogers and Alexander Sesonske May 26, 1963 23 p 5 refs
(Contract W-7504-eng-36)
(LAMS-2896) OTS: $0.50

The reaction of hydrogen and methane with graphite, above 1600° K, was found to give an apparent zero-order forward reaction and a one-half-order back reaction, based upon methane as the only reaction product. A possible reaction mechanism involves a slow step with rearrangement of the surface, followed by a fast step with two of the product species from the slow step combining to form methane. Forward rate activation energy values of 37.7 kcal/mole and 78 kcal/mole were obtained and were found to be strongly dependent upon the graphite used. Qualitative flow effects were observed. Pressures of the order of tens of atmospheres were used.
Author

N63-18116 Directorate of Materials and Processes, Aeronautical Systems Div., Wright-Patterson AFB, Ohio

SYNTHESIS AND PYROLYSIS OF METALS ALKOXIDES AS POTENTIAL REFRACTORY OXIDE COATINGS FOR GRAPHITE [Final Report, Jan. 1962-Feb. 1963]

K. S. Mazdiyasni and C. T. Lynch May 1963 47 p 12 refs
(ASD-TDR-63-322)

The vapor-phase deposition of hafnia and zirconia on graphite substrates, by decomposition of the isopropyl and tertiary butyl alkoxides, has been investigated. The infrared spectra of the isopropoxides of zirconium and hafnium have been obtained. Thorium isopropoxide infrared data have also been obtained, and the spectra compared with titanium and aluminum isopropoxides. The tertiary butoxides show more promise for coating applications because of their higher vapor pressures. The vapor pressures and decomposition temperatures of the zirconium and hafnium butoxides have been studied. Preliminary data on the oxidation resistance to

1000° C of various grades of graphite coated by this method are reported. The results indicate a potential route to more protective refractory coatings than are currently available. Author

N63-18140 Tennessee U., Knoxville
THE ADSORPTION OF POLAR ORGANIC COMPOUNDS ON FRESHLY MACHINED METAL SURFACES
Gopadi S. Hathwar and Hilton A. Smith May 27, 1963 139 p 72 refs
(Grant DA-ARO(D)-31-124-G-205)
(AROD-2281-4)

On the metal surfaces studied, adsorption of *n*-nonadecanol from cyclohexane solution was not observed under the conditions and concentrations used. Studies with unsaturated acids—linoleic acid and oleic acid—indicate that the adsorption on freshly machined metal surfaces is concentration dependent and there is polylayer formation. The extent of polylayer formation increases as the number of double bonds increases. The linoleic acid gives activities equivalent to 2 to 3 monolayers, whereas oleic acid gives only 1 to 2 monolayers. Metals such as copper, magnesium, lead and aluminum were used. The adsorption of calcium nonadecanoate on metal surfaces is physical in nature, following type II or IV adsorption isotherms at lower pressures. The attraction between the metal surface and the adsorbate is due to dipole-induced dipole interactions. There is no metal-ion exchange as shown by analytical methods. None of the metals (copper, magnesium, lead, and cadmium) that were employed gave a full monolayer coverage with calcium nonadecanoate, and the adsorption depended on the concentration. Author

N63-18143 Florida U., Gainesville
THE SYNTHESIS OF UNSATURATED FLUOROCARBONS Quarterly Report, Sept. 13–Dec. 13, 1962
Paul Tarrant, John Savory, David Sayers, Frank Pisacane, and Ward Oliver [1962] 17 p
(Contracts AF 33(616)-5701 and DA-19-129-QM-500)
(Rept. 46)

A study has been made of the reaction of sodium nitrosyl with hexafluorobenzene. No nitrosopentalfluorobenzene was formed. Two silanes containing the trifluorovinyl group have been synthesized, but no nitroso compound was formed. Trifluorovinyllithium did not react with hexafluorobenzene to give perfluorostyrene. A study was made of the reaction of perfluoroallyl chloride with $HgNO_3$. Author

N63-18168 Rensselaer Polytechnic Inst., Troy, N.Y.
ORTHO AND PARATRITIUM
E. W. Albers, P. Harteck, and R. R. Reeves [1963] 30 p refs
Presented in part at the 144th Natl. Meeting of ACS, Los Angeles, Mar. 1963 Submitted for Publication
(NASA Grant NsG-158-61)
(NASA CR-50363) OTS: $3.60 ph, $1.10 mf

The conversion of ortho-paratritium in the homogeneous gas and solid phases is reported. The extent of conversion was measured by a heat-conductivity cell cooled with liquid neon. The gas-phase conversion was observed at the temperature of liquid neon where the equilibrium concentration is one part ortho to one part paratritium. The role of an ion mechanism in this conversion is discussed. For the solid-phase conversion, the rate is two orders of magnitude faster than the rate for hydrogen. Consideration of the kinetic data for hydrogen, deuterium, and tritium in the solid phase and adsorbed phase indicates that a more favorable energy-transfer process may be operative for tritium and deuterium. Author

N63-18172 Los Alamos Scientific Lab., N. Mex.
HEATS OF DISSOCIATION OF GASEOUS CHLORIDES
R. C. Feber May 24, 1963 98 p 270 refs
(Contract W-7405-eng-36)
(LA-2841) OTS: $2.25

Available experimental data pertaining to the vaporization of chlorides of elements of the first long period of the periodic table and beyond are collected. Heats of formation and heats of dissociation of the gaseous chlorides at 298.15° K are calculated, and in some cases estimated. Heats of atomization of selected elements are reviewed. Author

N63-18180 Atomics International, Canoga Park, Calif.
DETERMINATION OF CARBON IN SODIUM BY ISOTOPE DILUTION MASS SPECTROMETRY
K. Y. Eng, C. D. Bingham, and R. A. Meyer [1962] 25 p 6 refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-7918) OTS: $0.50

A method utilizing isotope dilution mass spectrometry has been developed for the determination of elemental carbon in sodium. In the range of 50 to 150 μg of carbon, precision and accuracy of ±10 to 25 μg have been demonstrated. The determination is not affected by loss of generated carbon dioxide nor by contamination from any source except elemental carbon. Author

N63-18181 Colorado U., Boulder
RUBBER RESEARCH. THE SYNTHESIS OF SPECIAL FLUORINE-CONTAINING MONOMERS Fifth Quarterly Progress Report, Oct. 1, 1962–Jan. 1, 1963
J. D. Park and J. R. Lacher Jan. 20, 1963 18 p refs
(Contract DA-19-129-QM-1926)

Trifluoroacetyl nitrite was decomposed in the presence of iodine to trifluoroiodomethane, with a conversion of 65.4% and a yield of 53.5%. 1,3-Diiodohexafluoropropane was obtained in ca. 37% yield from the decomposition of disilver perfluoroglutarate in the presence of excess iodine. Perfluoroglutaric anhydride was prepared in 71% yield from the diacid chloride and water. Perfluoroglutaryl nitrite was prepared in 97.5% yield by the action of dinitrogen trioxide on the anhydride. Author

08 COMMUNICATIONS

Includes: communications equipment and techniques; noise; radio and communications blackout; telemetry; tracking; and wave propagation.

For tracking stations see: 10 Facilities.

For related information see: 06 Auxiliary Systems; 09 Electronics; 15 Instrumentation; and 22 Navigation and Guidance.

N63-17500 General Electric Co. Electronics Lab., Syracuse, N.Y.
AN INTRODUCTION TO MONOPULSE ANTENNAS
W. H. Nester Feb. 1963 40 p 5 refs
(R63ELS-6)

This paper discusses the basic concepts, techniques, and accuracy considerations of monopulse tracking. Author

N63-17505 California U., Berkeley. Electronics Research Lab.
Final Report, June 1, 1959–May 31, 1962 [RESEARCH ON CORRUPTED DATA PROCESSING SYSTEMS]

A. R. Bergen and C. A. Desoer June 1, 1962 15 p 26 refs
(Contract AF 19(604)-5466)
(Sci. Rept. 11; IER Ser. 60, Issue 472; AFCRL-62-780)

The work described includes research on randomly time-varying systems, optimal control systems, and the stability of nonlinear control systems. Author

N63-17521 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
THE MARINER 2 DATA PROCESSING SYSTEM
D. B. Sparks N.Y., AIAA [1963] 13 p Presented at AIAA Space Flight Testing Conf., Cocoa Beach, Fla., Mar. 18–20, 1963
(NASA Contract NAS7-100)

Introductory background information is given describing the data-processing facilities and equipment, the spacecraft data commutation scheme and modes of operation, and tracking and telemetry data-transmission formats. Treatment is then given to preflight, flight, and postflight processing of Mariner tracking and telemetry data by the Central Computing Facility at the Jet Propulsion Laboratory, Pasadena, California. Computer programs and their frequencies of use during the flight are described. Data-processing equipment, computer programs, and procedures used in the processing of tracking and telemetry data are presented with accompanying data flow charts, schedules, and statistics for the twenty-four-hour-per-day, 109-day interplanetary mission. Author

N63-17543 Office of Research Analyses. Mathematics Div., Holloman AFB, N. Mex.
FINE STRUCTURE OF THE DOPPLER SHIFT IN HETEROGENEOUS MEDIA Technical Report
Bruno Manz Mar. 1963 44 p refs
(ORA-63-8)

Formulae are developed for the Doppler shift at signals that either go directly from the emitter E to the missile M, or that reach the receiver R after they have been reflected from M. E, M, and R may have any velocity relative to the heterogeneous atmosphere. The derivation of the formulae accounts for the influence of the time needed for the frequency measurement on the Doppler shift. As a consequence, the refractive index, the velocities or velocity components that enter the formulae, are mean values over well-defined intervals in space or time. The relation between the error in the velocity measurement and the time measurement is established. Author

N63-17573 Stanford U. Stanford Electronics Labs., Calif.
DETECTION OF SOLAR PARTICLE STREAMS USING HIGH-FREQUENCY RADIO WAVES Scientific Report No. 2
B. B. Lusignan Apr. 1963 39 p 9 refs
(Contract AF 19(604)-7994)
(Tech. Rept.-1403-3; SEL-63-041; AFCRL-62-7994)

Interactions between radiowaves and charged particles change their character when the particles have high average velocities. The nature of such interactions is investigated, assuming no collisions, no external magnetic field, and low particle densities. A stream of such particles makes the medium anisotropic. As a result, the medium propagates two waves of unchanging (characteristic) polarization, one linearly polarized perpendicular to the particle stream, and a second at right angles to the first. Such a medium can change the polarization ellipse of a propagating wave. The sun produces such streams radiating outward either in the form of a steady "solar wind" or in bursts associated with sun spots. Three experiments are suggested to detect the streams by measuring polarization of waves propagated through them. The least sensitive of the three, moon radar, would have measurable effects only during increased solar activity, while the other two—transmission to a deep-space probe, and observation of polarized cosmic-noise sources—show effects even during quiet solar conditions. These sensitivities are based on observations of the proton component of the solar wind. Author

N63-17589 Raytheon Co., Norwood, Mass.
STUDIES IN DEEP STRATA RADIO COMMUNICATIONS Final Report
Joseph T. de Bettencourt and Raymond A. Sutcliffe Oct. 1962 518 p 97 refs
(Contract AF 19(604)-8359)
(AFCRL-63-60)

A simple model of an overburden above a semi-infinite rock stratum, with antennas immersed in the latter, has been used to explain certain effects observed on waves propagated through the rock between the antennas. Successful transmissions over a 1.1-mile path at Cape Cod have been obtained due largely to signal propagation through the rock near the overburden, rather than the up-over and down mode or any of the other modes of underground propagation. The experiments indicate that a detectable field on the surface is absent when strong wave-fields exist below, that the apparent strength of the signal received increases with an increase in depth below the overburden of the propagating waveguide, thus possibly indicating that rock conductivity may vary with depth, and that there is a difference in the shape of the field intensity vs. frequency curve for short-range propagations below the surface and in the air. Various types of antennas were used in the experiment, the best being polyethylene- or Teflon-coated wire, but a study with loop antennas is recommended. Some data on noise in underground transmission are presented, but is incomplete, as are preliminary modulation tests. Measurements of the pertinent constants of rock media are given, and the problems involved in obtaining such constants are discussed. D.E.R.

N63-17593 Aeronautical Research Labs., Wright-Patterson AFB, Ohio
AUTOMATIC OPTICAL RANGE FINDER
Werner Rambauske and Hubert Kuesters Feb. 1963 57 p
(ARL-63-48)

The different possible conventional methods usable for passive electronic range finding are analyzed; a new method is suggested which has considerable advantages over these. A working model to demonstrate this new method was designed and built for evaluation of experimental data, and detailed descriptions are given. Author

N63-17612 Hokkaido U. Research Inst. of Applied Electricity, Sapporo (Japan)
NETWORK SYNTHESIS WITH MULTIWIRE LINES
Akio Matsumoto 1963 100 p refs
(Contract AF 30(602)-2213)
(*Its* Monograph Series No. 11 (1963))

Network synthesis with multiwire lines is discussed. The propagation of waves along multiwire lines, with emphasis on lossless cases and the relations of voltages and currents at both ends of the line, is expressed in compact forms. Some fundamental properties of multiwire line networks are given for networks with open circuit ends, short circuits, ground connections, and ideal transformers. The line constants are calculated from the dimensions of the line. Type C and Brune sections are constructed with a 2-wire line, a Type C section is obtained from a 3-line wire, whose transmission zero is smaller or greater than 1, and 6 kinds of networks are shown which are the distributed equivalents of a Brune section. D.E.R.

N63-17632 Lincoln Lab., Mass. Inst. of Tech., Lexington
RADOMES, PART I, 15th Reference Bibliography [Period Covering 1952-Oct. 1962]
Teris Weinberger and Joseph F. Orabona Jan. 30, 1963 57 p 332 refs
(Contract AF 19(628)-500)

This bibliography covers the literature on both ground and airborne radomes from 1952 to October 1962. It is published in two parts: Part I contains the unclassified literature, and Part II consists of the classified material. The aspects of the radome field covered by this bibliography include theory, design, and experimental data and analyses of radome structures. Author

N63-17644 Texas Instruments, Inc., Dallas
SPEAKER RECOGNITION Final Report
Gary L. Holmgren May 1963 48 p 27 refs
(Contract AF 19(628)-345)
(Rept. 14-73801-14; AFCRL-63-119)

This research is concerned with defining a perceptual space within which listeners locate voices, to the end that the effects of manipulating speaker, hardware, and listener characteristics can be measured and, eventually, that specifications for elements of the communication system can be prepared to produce the desired system characteristics. In the experiments, taped speech samples were rated by listeners using Osgood's semantic differential method. Previous study indicated only four basic dimensions were required to account for ratings given speakers on a large number of characteristics. In a second experiment, a reduced number of characteristics, selected from the original list as best representing the four necessary factors, was used by listeners to rate speakers from AFCRL's speaker library. The experimental design allowed examination of the effects on ratings due to differences between listeners, due to repetition of the rating task, and to order of speaker presentation. Results of these examinations and the following are presented: (1) the adequacy of original factors to account for listener's ratings; (2) the differentiation between speakers; (3) the reliability of ratings; and (4) the familiarity of previously unheard voices. Author

N63-17713 Cruft Lab., Harvard U., Cambridge, Mass.
A METHOD OF MEASURING THE TIME-DEPENDENT IMPEDANCE OF THE LOAD
Keigo Iizuka Apr. 20, 1962 23 p 6 refs
(Contract Nonr-1866(32))
(Tech. Rept. 364)

By processing a sequence of scope pictures of the output from the probe of a standing-wave detector, placed successively at a sequence of positions along a slotted coaxial line, the instantaneous values of a nonstationary load impedance terminating a coaxial line may be measured. This method was applied to measure the instantaneous values of the impedance of a fast-response cadmium selenide photocell which has a rise and decay time of the order of milliseconds. The experiments were performed at 600 mc/sec. The experimental results were satisfactory, and a change that took place in a few milliseconds could easily be measured. Author

N63-17735 National Aeronautics and Space Administration, Washington, D.C.
RELAY SATELLITE TRANSMITS 'BRAIN WAVES' FROM ENGLAND TO MAYO CLINIC NASA News Release 63-85
Apr. 25, 1963 3 p
Available from NASA, Office of Scientific and Technical Information, Washington, D.C.

Electroencephalograms (brain waves) were transmitted by RELAY, communication satellite, from Bristol, England, to Minneapolis, Minnesota. The electroencephalograms were transmitted from Bristol by land lines to the British transmission station at Goonhilly, to RELAY and back down to the receiving station at Nutley, N.J., and by land line to Minneapolis. There, the signal was fed into a computer from which a diagnosis was made within one minute, and the results were immediately sent back to England. The combination of satellite transmission and computer analysis makes it possible to diagnose, over long distances, brain disorders and to determine which part of the brain is affected. N.E.A.

N63-17748 Case Inst. of Tech., Cleveland, Ohio
STUDY OF CONTROL OF APERTURE FIELDS Final Report, June 1958-Oct. 1962
Oct. 31, 1962 57 p 41 refs
(Contract AF 19(604)-3887)
(Sci. Rept.-35; AFCRL-62-932; AD-292989)

A summary of the problems and principal results obtained in the areas of surface-current measurements, antenna-pattern synthesis, artificial dielectric media, and network synthesis, during the four year period June 1958 to October 1962, is presented. Author

N63-17897 Vitro Labs., West Orange, N.J.
COMMUNICATION SYSTEMS TECHNIQUE BASED ON FUNDAMENTAL CONCEPTS OF JACQUES HADAMARD Final Report [Apr. 1962-Mar. 1963]
Richard G. Segers June 10, 1963 79 p 41 refs
(Contract AF 30(602)-2649)
(VL-2262-13-0; RADC-TDR-63-177)

This report presents a variety of fundamental investigations, with common analytical foundation in the work of Jacques Hadamard, conducted for the purpose of development of advanced communications systems. Chapter I presents a functional analysis approach to the demodulation problem as formulated in a system of integral equations by D. C. Youla. Its principal content is the discussion of the engineering significance of a quadratic variable principle that underlies the Youla formulation. Chapter II concentrates on mathematical considerations with the dual purpose of completing the arguments involved in Chapter I, and indicating where forward work is needed to enlarge the domain of the validity of the theory of Chapter I. Chapter III presents communication techniques derivable from incidence matrices of balanced incomplete block-design configurations. Author

N63-17929 Westinghouse Electric Corp. Electronics Div., Baltimore, Md.
HIGH POWER SOLID-STATE SWITCH STUDY Final Technical Report
Apr. 15, 1963 69 p 1 ref
(Contract AF 30(602)-2602)
(RADC-TDR-63-207)

This report describes the study, the design, and the development of a high-power solid-state radar modulator, operating into a resistive (dummy) load. Specifically, the report describes the study and experimentation performed on the individual inductive and solid-state components. The seriesing of Trinistors as well as Trinistor characteristics are described in considerable detail. The modulator breadboard is described and evaluated. The breadboard develops 5 megawatts of peak power and operates at 300 pps. The pulse width is approximately 5 microseconds. Author

N63-17933 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
INVESTIGATION OF ANALOG AND DIGITAL COMMUNICATION SYSTEMS (PHASE 3 REPORT) Final Report [Feb. 1962-Feb. 1963]

John G. Lawton et al Griffiss AFB, N.Y., Rome Air Development Center, May 1963 187 p 26 refs
(Contract AF 30(602)-2210)
(RADC-TDR-63-147)

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5. APPLICATION OF A PARTIAL ORDERING OF CHANNELS TO THE COMPARISON OF DIGITAL DATA SYSTEMS p 129–145 5 refs (See N63-17938 16-08)
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N63-17934 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
MAXIMUM LIKELIHOOD RECEPTION OF FM SIGNALS
In its Investigation of Analog and Digital Communication Systems (Phase 3 Report) May 1963 p 3–73 9 refs (See N63-17933 16-08)

The application of the method of maximum likelihood to the estimation of intelligence transmitted by frequency modulated signals is examined. When this method is applied to modulating systems with memories, such as FM signals, it is found to yield a pair of nonlinear integral equations, whose solution specifies the *a posteriori* most likely estimate, $a^*(\tau)$, of the modulating signal $a(\tau)$. In the case of additive white gaussian noise, the solution of one of the integral equations is obvious and the other is solved by simplification, assuming that the carrier frequency is large compared to the bandwidth and that for large signal-to-noise ratios the error goes to zero in a manner permitting linearization of the integral equation. The integral equations are derived using all available statistical data; it was assumed that this data consist of the autocorrelation functions of the modulating signal and the additive noise, while all the other parameters for the signals are known. If certain of these parameters differ from the assumed values, the effect of such difference can be computed from the dependence of the mean square error on variation of the received signal and noise strength and signal phase. D.E.R.

N63-17935 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
THRESHOLD EFFECTS IN FM RECEIVERS WITH RANDOMLY MODULATED SIGNALS
In its Investigation of Analog and Digital Communication Systems (Phase 3 Report) May 1963 p 74-99 1 ref (See N63-17933 16-08)

The threshold phenomenon in an FM receiver which consists of an ideal discriminator and a post-detection Wiener filter is examined for the case when the modulating signal is a gaussian random process with zero mean. For this type of modulating signal, the power spectrum of the discriminator output noise can be obtained by an approach due to Rice. Three difference cases are treated: (1) The power spectrum of the modulating signal is similar to that of a white noise passed through a first-order low pass filter, and an infinite delay Wiener filter is used; (2) the signal spectrum as in Case (1), but a zero delay Wiener filter is used; (3) the signal spectrum is constant in a limited band and zero outside, and an infinite delay Wiener filter is used. It is found that the carrier-to-noise (in the IF bandwidth) ratio at which threshold occurs depends on the modulation and IF bandwidth. Graphs showing performance near threshold are presented. Author

N63-17936 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
APPLICATION OF INFORMATION THEORY TO BOUND THE PERFORMANCE OF COMMUNICATIONS SYSTEMS
In its Investigation of Analog and Digital Communication Systems (Phase 3 Report) May 1963 p 100–106 5 refs (See N63-17933 16-08)

Application of the information theory in establishing bounds on the attainable performance of communications systems is investigated. By the fundamental information theory, it is possible to transmit continuous information over a channel with the rate of generation of information dependent on the capacity of the channel, the mean square error, the bandwidth, and signal power, besides the intensity of the noise. An equation can be derived which is used to yield a valid bound for the maximum attainable ratio of source entropy power to mean square error between the output and input of a system containing a channel perturbed by additive white gaussian noise. The bounds apply to communications systems which involve a delay at both the transmitter and receiving terminals when code words are communicated. D.E.R.

N63-17937 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
TRANSMISSION OF ANALOG INFORMATION OVER A DIGITAL CHANNEL
In its investigation of Analog and Digital Communication Systems (Phase 3 Report) May 1963 p 107–128 4 refs (See N63-17933 16-08)

Some of the characteristics and limitations of digital systems used to transmit analog data are reviewed and compared with recent work establishing bounds on the error rate performance of a digital link. Analog data can be transmitted by means of a digital link with an optimum signal-to-noise ratio and a reduction of transmitted power but at the expense of increased channel bandwidth. In order to use such a system, though, certain relationships must be established: the signal-to-noise ratio, the error rate performance, the performance of pulse-code-modulated channels using binary keying when errors are distributed uniformly, the relationship of bounds on the digital system to analog limitations, and the ratio of the source entropy power to the mean square error. D.E.R.

N63-17938 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
APPLICATION OF A PARTIAL ORDERING OF CHANNELS TO THE COMPARISON OF DIGITAL DATA SYSTEMS
In its Investigation of Analog and Digital Communication Systems (Phase 3 Report) May 1963 p 129–145 5 refs (See N63-17933 16-08)

The results of Wolf concerning the comparison of digital systems with different size transmission alphabets are extended to include systems characterized by general rectangular probability matrices, as well as the digital systems characterized by square, symmetric transition probability matrices. The comparison is based on the partial ordering of communication channels with respect to a relation of inclusion, written ≥. So, if K_1, K_2, and K_3 are any channels: (1) $K_1 \geq K_1$, (2) if $K_1 \geq K_2$ and $K_2 \geq K_1$, then $K_1 = K_2$, and (3) if $K_1 = K_2$ and $K_2 \geq K_3$, then $K_1 = K_3$. This method of comparison (1) encompasses channels represented by arbitrary transition matrices between input and output symbols; (2) relates directly to Shannon's partial ordering of channels in the sense that, if one channel includes a second, it is at least as reliable as the second independently of the size of the comparison alphabet; and (3) duplicates Wolf's results for the special cases treated in his note, "On Comparing N-ary Systems." D.E.R.

N63-17939 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
OPTIMIZATION OF DIGITAL COMMUNICATION SYSTEMS OPERATING OVER A DISPERSIVE CHANNEL. OPTIMIZATION IN THE FREQUENCY DOMAIN
In its Investigation of Analog and Digital Communication Systems (Phase 3 Report) May 1963 p 146–168 2 refs (See N63-17933 16-08)

This analysis is concerned with optimization in the sense of minimizing probability of error of a digital communication system, where control is maintained over both the transmitter waveforms and the receiving system, but not over the channel transfer function or the noise properties. The transmitted signals are assumed to occur independently and with equal probabilities. The energy and duration of the transmitted signals are specified. The noises added at the input and output of the dispersive channel are assumed gaussian, but not necessarily white; hence, a linear receiver is used. Matrix equations give the relationships which must exist in an optimum system among the signal, receiver, channel, and noise functions. For a particular situation, i.e., specified channel transfer function and noise autocorrelation function, the form of the solution is obtained. That is, series expressions for the optimum transmitted waveforms and the impulse responses of the receiving filters are developed. The coefficients of the series have, however, been specified only for the binary case. Interesting orthogonality properties which the component function possess are developed. Author

N63-17951 Navy Electronics Lab., San Diego, Calif.
SLOTTED-RIDGE WAVE GUIDE PLANAR ARRAYS Research and Development Report [Jan. 1961–July 1962]
J. H. Provencher and W. W. Grant Apr. 24, 1963 29 p 6 refs
(NEL-1165)

Standard rectangular wave guides, loaded by the use of ridge, have been designed to make parallel-slot antenna arrays capable of being scanned ±45° off the broadside position. The array design is proposed as a means of using the same aperture for multiple-frequency bands. Radiation patterns of 36-slot and 72-slot planar arrays are included. Author

N63-18005 Cruft Lab., Harvard U., Cambridge, Mass.
THEORETICAL AND EXPERIMENTAL STUDIES OF ANTENNAS AND ARRAYS IN A PARALLEL-PLATE REGION. PART III—SOME INVESTIGATIONS ON A TWO-ELEMENT YAGI-TYPE ARRAY IN A PARALLEL-PLATE REGION Scientific Report No. 1, Series 3
B. Rama Rao Mar. 15, 1963 27 p 3 refs
(Contract AF 19(628)-2406)
(AFCRL-63-107)

The directional characteristics and input impedance of a two-element Yagi-type array in a parallel-plate region have been studied. The optimum values of the tuning reactance and interelement spacing at which the parasite gives the best performance, either as a reflector or as a director, have been obtained. The radiation fields in the directions away from and toward the parasite, and the input impedance to the array have been measured experimentally and found to be in good agreement with theory. Author

N63-18007 Cruft. Lab., Harvard U., Cambridge, Mass.
THEORETICAL AND EXPERIMENTAL STUDIES OF ANTENNAS AND ARRAYS IN A PARALLEL-PLATE REGION
B. Rama Rao Oct. 5, 1962 101 p 27 ref
(Contract AF 19(604)-4118)
(Sci. Rept.-15 (Ser. 2): AFCRL-63-90)

The integral equation for the current on the antenna has been formulated using Green's theorem and a suitable Green's function based on the method of images; the resulting equation has been solved by expressing the current as a Fourier series in terms of waveguide modes. It has been shown that in the case of thick antennas, the logarithmic term in the current, due to the idealized delta-function generator, makes a marked contribution over a significant length of the antenna, and the so-called "transition" region is much larger than for the free-space antenna. The admittance of the theoretical model can be brought into good agreement with the experimental results by subtracting out the infinite gap capacitance, and replacing it by an empirical correction term to account for the input susceptance of the actual feeding gap. An anomaly in the behavior of the antenna at resonance can be avoided by assuming a complex propagation constant in the guide, due to small but finite losses in the image planes. Closed form expressions for the current and admittance have been obtained and compared with experimental results. The general agreement is found to be good. Author

N63-18008 Cruft Lab., Harvard U., Cambridge, Mass.
THEORETICAL AND EXPERIMENTAL STUDIES OF ANTENNAS AND ARRAYS IN A PARALLEL-PLATE REGION. PART II—THE CURRENT DISTRIBUTION AND IMPEDANCE CHARACTERISTICS OF COUPLED ANTENNAS IN A PARALLEL-PLATE REGION
B. Rama Rao Mar. 15, 1963 66 p 3 refs
(Contract AF 19(604)-4118)
(Sci. Rept. 16 (Ser. 2): AFCRL-63-106)

The current distribution and impedance characteristics of two identical, coupled antennas in a parallel-plate region are studied theoretically and experimentally. The simultaneous integral equations for the current distribution on the coupled antennas have been solved by the method of phase-sequence components. Numerical values for the self and mutual admittances have been calculated for identical antennas of length $h = 0.25\lambda$, and radius $a = 0.0105\lambda$, and for spacings in the range $0.02 \leq b/\lambda \leq 1.0$ where b is the distance between the antennas. The current distribution, self and mutual admittances of the antennas have been measured, and are found to be in good agreement with theory. A description of the apparatus and measuring techniques is included. Author

N63-18036 RAND Corp., Santa Monica, Calif.
CROSSTALK OF FREQUENCY-MULTIPLEXED SIGNALS IN SATURATING AMPLIFIERS
Worthie Doyle Apr. 1963 30 p 5 refs
(NASA Contract NASr-21(02))
(NASA CR-50334; RM-3576-NASA) OTS: $2.60 ph, $1.00 mf

For amplifiers with narrow dynamic range, the crosstalk may be unacceptably high when channels are numerous or close together. An investigation is made of the trade-offs among number of channels, spacing, and crosstalk. When there are many channels, the total interference of any one of them may be regarded as a gaussian noise. The channel being interfered with is here represented as a separate gaussian signal, so that the total input is one big gaussian process. The channel spacing is incorporated in this model by specifying a spectrum composed of equally spaced, identical bands. The main result of

analyzing the model assumed is that there are no simple tradeoffs, and that the crosstalk cannot be usefully reduced by guardbands so long as the channels are equally spaced. For the central channel, the worst case, the output signal and crosstalk spectra are given. Also presented are the signal-to-crosstalk ratios in rectangular output filters for a limited number of cases.
Author

N63-18053 Air Force Systems Command. Control Systems Lab., Griffiss AFB, N.Y.
DUAL PATTERN ANTENNA, APPLICATION TO IFF INTERROGATION SIDE LOBE SUPPRESSION
R. E. Scott June 1963 35 p 1 ref
RADC-TDR-63-257)

This report describes a nonconventional IFF antenna system developed for use with the AN/CPN-4/GPX-8A ATC Radar-IFF System. A flight-test program was conducted at RADC's Verona Test Site for the purpose of testing the capabilities of this antenna to function properly in an IFF Side-Lobe Suppression System. The data presented are, for the most part, in the form of composite pictures of returns from an aircraft flying various radial paths across the Verona Test Site, and free-space antenna patterns taken at the Newport Antenna Test Range. Results show that the antenna has the desired capability.
Author

N63-18191 Illinois U. Electrical Engineering Research Lab., Urbana
STUDY AND INVESTIGATION OF MILLIMETER AND SUBMILLIMETER WAVE RECEIVER TECHNIQUES Final Report, Mar. 1, 1961–Feb. 28, 1963
Paul D. Coleman et al Mar. 29, 1963 41 p 12 refs
(Contract AF 30(602)-2456)
(RADC-TDR-63-170)

This program has as its goal the development of video detection techniques which are usable in the millimeter and submillimeter wave range of the spectrum. A pyroelectric detector which uses triglycine sulfate as the detecting material has been developed and tested in microwave systems at wavelengths of 8.15 mm, 4.10 mm, and 2.14 mm. The minimum detectable power with the present configuration is 8 μwatts at the longer wavelengths, and between 20 and 200 μwatts at 2.14 mm. A similar detector using barium titanate as the detecting material did not prove to be as sensitive as the triglycine sulfate unit. An analysis for the metal reflecting beam waveguide has been developed. It is found that the reflectors should be sections of oblate spheroids. An experimental wall current detector for use with the beam waveguide has been built. Initial tests were encouraging.
Author

09 ELECTRONICS

Includes: circuits and circuit theory; electronic components (e.g., tunnel diodes, transistors, and tubes); and feedback and control theory.

For related information see: 06 Auxiliary Systems; 08 Communications; 15 Instrumentation; 22 Navigation and Guidance; and 25 Physics, Solid-State.

N63-17487 Hughes Aircraft Co., Culver City, Calif.
A WAVEGUIDE SLOT SWITCHING TECHNIQUE Scientific Report No. 5
F. J. Goebels, Jr. and C. H. Nonnemaker, Jr. Apr. 1963 29 p 3 refs
(Contract AF 19(604)-8386)
(AFCRL-63-138)

This report describes a series of experiments on a novel technique which permits a slot radiator in a waveguide to switch its radiation on and off by means of a compact circuit located at the plane of the slot and within the wall thickness of the waveguide feed line. The switching technique is applied to an end-plate series slot. It is electronically operated by means of a d.c. biased varactor diode. As a reference, the switch characteristics when operated by a mechanical tuning plunger are also given. An analytical description of the technique is also included. The experiments were conducted at S-band and at X-band. The S-band model when operated mechanically provided a slot switching ratio of 38 db, and when operated electronically gave a ratio of 35.6 db. Similar operation with an X-band model yielded 50 db and 16.1 db, respectively. These results were obtained at the original resonant frequency of the slot, i.e., the presence of the switching circuit did not change the slot resonant frequency.
Author

N63-17494 Utah U. Microwave Devices Lab., Salt Lake City
MAGNETO-ELECTRIC COMPRESSION OF AN ELECTRON BEAM
Lucky Kikushima and C. C. Johnson Apr. 1963 41 p 10 refs
(NSF Grants G-15017 and GP-843)
(NSF-3)

Equations of motion describing the trajectory of the beam edge electrons in a magnetic field buildup region have been derived and solved. The solutions are compared with those obtained from equations assuming a constant axial velocity which is an approximation to the actual case. Trajectory and design curves were plotted from the solutions obtained. The entrance slopes, entrance radii, and magnetic field have slightly higher values for the exact case. From the design curves an experimental tube was built and tested. Beam measurements indicated that a Brillouin focused beam about 0.013 inches in diameter was obtained at 10 KV and 2.4 amps. This corresponds to a current density of 2,500 amps per sq. cm. and a power density of 25 megawatts per sq. cm. This is a very useful beam for high power and high frequency tubes.
Author

N63-17510 Cutler-Hammer, Inc. Airborne Instruments Lab., Deer Park, N.Y.
IMPROVED RADIO DOPPLER DETECTORS Final Report
John L. O'Connor and James B. Leary Mar. 1963 44 p
(Contract FAA/BRD-385)
(Rept. 1372-1)

This report describes the program of RF Doppler detector improvement undertaken to eliminate deficiencies in the radio detectors used in the TRACE installation at NAFEC. Four X-band FW-CW Doppler detectors and two dual-antenna CW S-band Doppler detectors, modified from GFE supplied by the FAA, were developed under this program and delivered to NAFEC for test and experimentation. These detectors eliminate or greatly reduce detection of the unwanted targets by producing a "dead zone" immediately in front of the detector. The X-band FM-CW detector produces this zone where detection is eliminated by a frequency modulation technique, while the CW S-band unit uses physical separation of the receiver and transmitter antennas to achieve the same result.
Author

N63-17537 California U., Livermore. Lawrence Radiation Lab.
A METHOD FOR SUPPRESSING PHOTOMULTIPLIER NOISE

R. W. Hill and J. P. Stoering Jan. 1, 1963 10 p 7 refs
(Contract W-7405-eng-48)
(UCRL-6886, Rev. 1) OTS: $0.50

A system is described that takes advantage of the difference in pulse length of slow-decay-time scintillators such as CsI(T1) and NaI(T1) and the photomultiplier noise. The system uses mostly standard electronic components. Since noise pulses occur at random and the individual signal pulses are correlated by the decay time of the scintillator, it is possible to separate the signal pulses due to two or more photoelectrons from the noise by making use of this time correlation. N.E.A.

N63-17627 Bendix Corp. Bendix Radio Div., Baltimore, Md.

A RADIAL FLIGHT PATH CONTROLLING SYSTEM FOR AN/ASM-13 Final Report

A. E. F. Grempler Griffiss AFB, N.Y., Rome Air Development Center, May 1963 33 p 3 refs
(Contract AF 30(602)-2803)
(RADC-TDR-63-128)

This report is a summary of services performed by the Bendix Radio Division in developing a radial flight-path controlling system for the ASM-13 antenna pattern analyzer. The design, fabrication, and installation of the system in an Air Force C-131B aircraft are discussed. Also included are the results of an acceptance test conducted at Friendship Airport, Baltimore, Maryland. Author

N63-17669 Illinois U., Urbana

A STUDY ON SATURATION PHENOMENA

Sergio T. Ribeiro Apr. 9, 1962 66 p
(Contract Nonr-1834(15))
(Rept. 115)

The relative influence of saturation physical phenomena on general degeneration of transistor properties was investigated. Small signal parameters of a circuit's current were measured as functions of the biasing emitter's input current and the voltage drop across the collector resistance so as to give an approximation of the transistor's physical properties. Certain transistors were found to have an emitter current larger than the collector current for certain values of emitter input current and collector voltage drop resulting in a supersaturation effect of reverse current gain. This occurs only at high values of emitter input current and low values of collector voltage drop, is critical with respect to variations of the input current, voltage drop, and temperature, and, in the transistors studied, occurs only in the GF-45011 and S-166 type transistors. D.E.R.

N63-17814 General Dynamics Corp. General Atomic Div., San Diego, Calif.

A DIGITAL-COMPUTER CODE FOR THE ANALYSIS OF THERMIONIC NETWORKS

J. H. Broido, C. W. Savery, and W. B. Wright May 22, 1963 77 p 6 refs
(Contract NObs-86221; ARPA Order 219-61)
(GA-4147)

A digital-computer code which describes the performance of thermionic diodes has been developed. Detailed data derived from research on these diodes are incorporated in the library of this code. With the data now available, semiquantitative estimates can be made of the thermionic performance of single diodes and of networks of these diodes in a reactor environment. The calculations that the code performs are based upon a phenomenological model of energy transfer in the diode using experimental current-voltage data. As more and better data become available, the library can easily be extended without changing the format of the code. R.C.M.

N63-17898 General Electric Co. Spacecraft Dept., Philadelphia, Pa.

THE MASTER CONTROL SYSTEM APPLIED TO ELECTRONIC MODULES

H. R. Daw, C. S. Kowalski, and R. E. Waite Oct. 1962 17 p
(Rept. 62SD215)

A unique defect-reporting system based on statistical control chart techniques, developed by the General Engineering Laboratory for mass-production operations, has been modified and applied to a research-and-development type job shop operation in the Missile and Space Division. Implementation of this "pyramiding" technique of reporting defect information coupled with the issuance of operator charts has resulted in a defect-rate reduction of 85%. Author

N63-18000 California U., Berkeley. Lawrence Radiation Lab.

ELECTRICAL DESIGN OF ELECTROSTATIC DEFLECTORS FOR SECTOR-FOCUSED CYCLOTRONS

Bob H. Smith and Hermann A. Grunder Mar. 25, 1963 37 p 15 refs
(Contract W-7405-eng-48)
(UCRL-10654) OTS: $0.75

The new sector-focused cyclotrons have more energetic and better focused beams at the extraction radius than do ordinary cyclotrons. While the first characteristic requires a more intense electric field, the second permits this field to extend over a smaller volume. By tailoring the electrode geometry to these characteristics of the beam, the required deflector gap and electrode surface become smaller, and a higher gradient can be held without sparking. A different compromise between radioactivity, power dissipation, and resistance to spark damage must be made in selecting electrode materials. Carefully designed electrostatic deflectors perform very well in sector-focused cyclotrons of intermediate energy. Deflector efficiencies of about 50% and external-beam intensities of 20μA have been obtained in the Lawrence Laboratory's 88-Inch Cyclotron. Author

N63-18004 Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge

SOME MEMORY ASPECTS OF FINITE AUTOMATA

Chung Laung Liu (Ph.D. Thesis) May 31, 1963 75 p 4 refs
(Contract DA-36-0390-SC-78108; Grant DA-SIG-36-039-61-G14)
(MIT-TR-411)

The most important characteristic of a finite automaton is that it has a "memory." By this, it is meant that the behavior of an automaton is dependent upon its past history. Several special cases are studied in which the unique determination of the behavior of an automaton is possible, even when a portion of its past history is unknown. Author

N63-18006 Cruft Lab., Harvard U., Cambridge, Mass.

THEORETICAL AND EXPERIMENTAL STUDIES OF ANTENNAS AND ARRAYS IN A PARALLEL-PLATE REGION. PART IV – WAVE PROPAGATION ALONG INFINITE YAGI-TYPE ARRAY IN A PARALLEL-PLATE REGION Scientific Report No. 2, Series 3

B. Rama Rao Mar. 15, 1963 47 p 6 refs
(Contract AF 19(628)-2406)
(AFCRL-63-108)

An approximate expression for the phase velocity of wave propagation along an infinite Yagi-type array in a parallel-plate region has been derived by a variational method. The dependence of the propagation constant on the various geometrical parameters of the array is discussed. For antenna length less than a half-wavelength, and for short distances between elements, it has been shown that there can be two independent surface-wave modes propagating along the structure. A transcendental equation for the propagation constant of the periodic structure has also been obtained by a more rigorous impedance approach, taking into account the mutual coupling between antenna elements. The design and fabrication of the experimental equipment is described. An outline of the proposed experimental work is given, and methods for measuring the propagation constant, gain, front-to-back ratio, current-distribution on the elements, radiation pattern, input impedance, longitudinal and transverse field distribution, and excitation efficiency of the array are described. Author

N63-18049 Stanford Research Inst., Menlo Park, Calif.
DEVELOPMENT OF HIGH ENERGY BATTERIES Quarterly Progress Report No. 4, July 1-Sept. 30, 1960
E. F. Duffek Mar. 27, 1961 4 p
(NASA Contract NASw-111)
(NASA CR-50136) OTS: $1.10 ph, $0.80 mf

Work was centered on lithium as the anode for high-energy batteries and use of cathode coating materials other than Halane. It was observed that the potential of a platinum electrode versus the lithium anode remained practically unaffected while the terminal voltage dropped to zero. This indicates that, under the experimental conditions used, the main limitation of the cell is in the Halane cathode rather than in the lithium anode. The difficulties with the Halane cathode are believed to be caused by the formation of a gaseous or solid layer which interferes with the contact between the carbon grain and the active material. In some cases, a poorer discharge behavior was observed with the lithium alone than when the lithium was backed by a copper plate. This could be due to the smaller pressure exerted by the rubber bands in the former case. If this is true, the cell's performance would depend on the pressure between the electrodes, just as in the zinc electrode in the silver-zinc battery. C.L.W.

N63-18068 National Research Council of Canada. Div. of Mechanical Engineering, Ottawa
A DIGITAL SIMULATION APPARATUS FOR HUMAN OPERATOR STUDIES, WITH PARTICULAR REFERENCE TO THE CONTROL OF VTOL AIRCRAFT
E. R. Petersen *In* National Research Council of Canada, Ottawa Quarterly Bull. of the Div. of Mech. Eng. and the Natl. Aeron. Estab., 1 Jan. to 31 Mar. 1963 p 41-55 8 refs (See N63-18066 16-01)

To optimize the man-machine combination in complex control situations, such as those encountered in the control of a VTOL aircraft, a simulation apparatus has been designed that uses computers to approximate the conditions aboard a VTOL aircraft in hovering or near-hovering flight and to actuate the "moving platform" and visual displays. The required "real-time" simulation equipment is described and simulation methods, using analog and digital computers, are compared as to their speed, accuracy, reliability, size and power, cost, expansion, and flexibility. The apparatus to be installed in the mechanical engineering division of the National Research Council is described; the unit uses a digital processor, convertor links, an analog coupling unit, an interval timer, and conventional input-output equipment. D.E.R.

N63-18084 Technische Hochschule München. Inst. für Hochfrequenztechnik (W. Germany)
RESEARCH ON ELECTRICALLY SMALL ANTENNAS Summary Report No. 2
H. H. Meinke Apr. 30, 1963 114 p 12 refs
(Contract AF 61(052)-506)
CONTENTS:
1. ELECTRICALLY SMALL ANTENNAS EMBEDDED IN A DIELECTRIC OR MAGNETIC MEDIUM H. H. Meinke p 1-44 8 refs (See N63-18085 16-09)
2. FOLDED DIPOLE ANTENNA WITH TUNNELDIODE H. H. Meinke p 45-91 4 refs (See N63-18086 16-09)

N63-18085 Technische Hochschule München. Inst. für Hochfrequenztechnik (W. Germany)
ELECTRICALLY SMALL ANTENNAS EMBEDDED IN A DIELECTRIC OR MAGNETIC MEDIUM
H. H. Meinke *In its* Research on Electrically Small Antennas Summary Rept. No. 2 Apr. 30, 1963 p 1-44 8 refs (See N63-18084 16-09)

Performance improvement of the electrically small antenna can only be obtained by achieving a bandwidth enlargement of the antenna impedance. By surrounding the antenna with ferrite of the same maximum height as the antenna, a bandwidth enlargement is only possible if the geometrical height of the antenna becomes larger than about 1/20 of the wavelength in air. The outer regions of the ferrite form cause this bandwidth broadening effect. Author

N63-18086 Technische Hochschule München. Inst. für Hochfrequenztechnik (W. Germany)
FOLDED DIPOLE ANTENNA WITH TUNNELDIODE
H. H. Meinke *In its* Research on Electrically Small Antennas Summary Rept. No. 2 Apr. 30, 1963 p 45-91 4 refs (See N63-18084 16-09)

Stability problems and measurement of input impedance with negative resistances are discussed. A folded unipole with a tunneldiode at its top is studied experimentally. Author

N63-18090 ITT Federal Labs., Nutley, N.J.
SOLID STATE TACAN RECEIVER/CODER Interim Scientific Report
N. R. Ascione, J. C. Cozzie, and R. E. Torregrossa Bedford, Mass. Electronics Systems Div. Mar. 1963 52 p 5 refs
(Contract AF 19(604)-8352)
(ESD-TDR-63-128)

The initial design of a receiver-coder for use as part of a solid-state TACAN transponder is discussed. Techniques developed for specific problem areas are covered, and experimental results obtained from a breadboard model are given. The possible implications of the program on future TACAN development are examined, and recommendations are made for the future course of development. Author

N63-18091 Istituto Universitario Navale, Naples (Italy)
STEP APPROXIMATION OF A TAPERED MATCHING OR ABSORBING JUNCTION Technical Note No. 2
Giorgio Franceschetti May 31, 1963 55 p 14 refs
(Contract AF 61(052)-589)
(RADC-TDR-63-315)
CONTENTS:
1. A CONTRIBUTION TO THE SYNTHESIS PROBLEM OF DISTRIBUTED PARAMETERS MATCHING JUNCTIONS OR TERMINATION G. Franceschetti p 1-40 10 refs (See N63-18092 16-09)
2. THE INHOMOGENEOUS LINE, OR LAYER, AS A MATCHING DEVICE G. Franceschetti 5 p 4 refs (See N63-18093 16-09)

N63-18092 Istituto Universitario Navale, Naples (Italy)

A CONTRIBUTION TO THE SYNTHESIS PROBLEM OF DISTRIBUTED PARAMETERS MATCHING JUNCTIONS OR TERMINATION

Giorgio Franceschetti *In its* Step Approximation of a Tapered Matching or Absorbing Junction Tech. Note No. 2 May 31, 1963 p 1-40 10 refs (See N63-18091 16-09)

A simple synthesis method of tapered matching junctions or termination is briefly discussed. The advantages of the method are illustrated. The possibility of realizing layered matching or terminating junctions, with performance as close as possible to that of the tapered junctions, is discussed. The use of analog computers for performing the synthesis of matching or absorbing sections is described, and the relative programs are given. Author

N63-18093 Istituto Universitario Navale, Naples (Italy)

THE INHOMOGENEOUS LINE, OR LAYER, AS A MATCHING DEVICE

Giorgio Franceschetti *In its* Step Approximation of a Tapered Matching or Absorbing Junction Tech. Note No. 2 May 31, 1963 5 p 4 refs Repr. from Alta Frequenza v. 31, 11, 1962 (See N63-18091 16-09)

The approximation of a tapered matching or absorbing junction by means of a number of homogeneous layers is discussed. A method to obtain the closest performance between the two junctions is developed. Some considerations about the practical realization of the junctions are added. Author

N63-18095 Grumman Aircraft Engineering Corp., Bethpage, N.Y.

INVESTIGATION OF WET TANTALUM CAPACITORS FOR SPACE APPLICATIONS

J. J. Metzger Dec. 27, 1962 7 p

(ADN-03-16-62.1)

No conclusive data as to the suitability of wet-type capacitors for space applications have been received from capacitor manufacturers. Nuclear-radiation effects data are conflicting. Vacuum test of 42 capacitors was begun in October 1962, at GAEC. 1200^+ hours have been logged to date in a vacuum greater than 1×10^{-5} torr, at +71° C with 80% of rated DCWV applied. Three possible failures have occurred. Author

N63-18170 Rome Air Development Center. Information Processing Lab., Griffiss AFB, N.Y.

A NEW CONCEPT IN ARTIFICIAL INTELLIGENCE

John P. Choisser and John W. Sammon, Jr. May 1963 9 p

(RADC-TDR-63-228)

The primary subject of discussion in this report is the conceptual aspects of CHILD (*C*ognitive *H*ybrid *I*ntelligent *L*earning *D*evice). CHILD is a self-adaptive learning machine. An attempt is made to describe learning machines in a functional sense in order to isolate the unique properties of this concept. To do this, learning machines must be placed on some common ground. Therefore, adaptive learning devices will be viewed as networks of redundant adaptive elements which are capable of being organized by some "learning" logic. The common function performed by the learning machines under consideration here consists basically of a remapping of the sensory space in some manner which will enable decision elements to divide the remapped sensory inputs into various classes. The primary adaptive function of such machines is (or should be) the determination of the transformation(s) required in order to successfully solve the given problem. With this common basis for comparison, the unique properties of CHILD as a new concept in artificial intelligence should become apparent. Author

N63-18204 Montana State Coll. Endowment and Research Foundation. Electronics Research Lab., Bozeman

ON DYNAMIC SWITCHING IN ONE-DIMENSIONAL ITERATIVE LOGIC NETWORKS

W. L. Kilmer Mar. 1963 30 p 7 refs

(Contract AF 19(604)-6619)

(AFCRL-63-68)

A SITN is a cascade of identical finite automata such that the i^{th} automaton receives an x_i input from the outside world and a y_i input from its left neighbor, and produces a z_i output to the outside world and a y_{i+1} output to its right neighbor. Three main theorems are proved: (1) For every integer k there is a cell definition such that a corresponding SITN either can or cannot switch from equilibrium to a cycling condition following a single x_i change, according as $n \leq k$ or $n > k$, respectively. (2) There do not exist algorithms to tell whether or not a given cell definition admits of a SITN that can start from equilibrium, and following a single x_i change either (a) switch into a cycling condition, or (b) put out $z_i = 1$ during a switching transient. (3) There do not exist algorithms to tell whether or not a given SITN cell definition must have every switching transient following a single x_i change from equilibrium either (a) die out a bounded number of cells to the right of the change, or (b) extend all the way to the SITN boundary. All theorems are proved constructively on finite-state diagrams, and (2) and (3) hinge on an embedding of Minsky's Post Tag system results into such diagrams. Several iterative network equivalence demonstrations are included. Author

10 FACILITIES

Includes: airports; lunar and planetary bases; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands and wind tunnels); test ranges; and tracking stations.

For related information see: 06 Auxiliary Systems.

N63-17490 California U., Los Angeles

FEASIBILITY STUDY OF A SMALL THERMAL CHAMBER FOR PROGRAMMED TRANSIENT INCREASES AND DECREASES IN TEMPERATURE [Final Report]

Jeremy Crocker and John Lyman Wright-Patterson AFB, Ohio. Biomedical Lab., Mar. 1963 41 p 25 refs

(Contract AF 33(616)-6763)

(AMRL-TDR-63-15; Eng. Dept. Rept. 63-1; Biotechnology Lab. Rept. 14) OTS: $1.25

After a brief review of experimental requirements and practical constraints, performance specifications of a rate of change of 200° F per minute and a maximum temperature of 600° F were arbitrarily set for a possible thermal-chamber facility. Various methods of heating were examined, and the decision was made to make a special study of a fluid-wall thermal chamber as a promising approach to achieve the desired specifications. It was found that it should be possible to construct a circulating-fluid wall chamber, using commercially available silicone derivative fluids for under $40 per square foot of area, plus a fixed cost for controlling equipment. Based on approximate figures, it was concluded that an 8-foot chamber meeting the desired specifications, and with a capability for extending its operation into a thermal range below room temperature, could be constructed for under $50,000. Author

N63-17501 Federal Aviation Agency. Systems Research and Development Service, Washington, D.C.
CENTRAL ALTITUDE RESERVATION FACILITY (CARF) ACTIVITY FORECAST, 1962-67 Interim Memorandum Report
Richard G. Brown June 1963 44 p

This report pertains to forecasts of Altitude Reservations processed by the Central Altitude Reservation Facility (CARF) located at Kansas City, Missouri. Altitude reservations are used primarily by the military services for the mass movement of aircraft, or for special requirements which can not be met satisfactorily without altitude reservations. The basic objective of this study was to evaluate present and future altitude reservation activity in support of an automation feasibility study of CARF. There were 14,368 altitude reservations encompassing 43,463 aircraft processed in 1962. The daily average was 39 altitude reservations processed. The average of the 12 monthly peak days was 79 ALTRVs with 181 ALTRVs for the annual peak day. Altitude reservations are expected to rise to a peak of 18,997 in 1964, primarily through the inception of positive control across the country, and decrease to 15,126 annually by 1967 because of reduced usage by the Strategic Air Command.
Author

N63-17642 Sandia Lab., Albuquerque, N. Mex.
THE DESIGN OF A DUST-CONTROLLED VENTED HOOD UTILIZING LAMINAR AIR FLOW
W. J. Whitfield June 1963 18 p
Supported by AEC
(SC-4905(RR) OTS: $0.50

This report describes a laminar air-flow-vented clean hood, and presents performance data for it. This open-front hood provides a clean work area for operations which require removal of particles or noxious gases. This hood provides dust levels of less than 1000 particles per cubic foot 0.32 micron and larger.
Author

N63-17643 Weapons Research Establishment (Australia)
TIMING STANDARD, W.R.E. SALISBURY
L. L. Anderson Feb. 1963 37 p 12 refs
(EID-12)

The Salisbury Timing Standard was commissioned in October, 1960. It serves as the master time-and-frequency reference for the Australian Missile Range. As such, it provides a large number of timing signals that are accessible on special lines and radio transmissions. The Range Timing Centre, Woomera, maintains its timing in close agreement with the Salisbury Standard by daily phase adjustments. It is the responsibility of the Salisbury center to maintain close agreement with Universal Time and to provide accurate frequencies. To this end, extensive monitoring of national and international time-and-frequency transmission is undertaken. This report describes the Timing Standard, its equipment, the techniques of operation, and its performance. Some description is also given of the basic time-scales presently used and the limitations of radio transmissions for time-and-frequency comparisons.
Author

N63-17668 Advisory Group for Aeronautical Research and Development, Paris (France)
REQUIREMENTS FOR AN AXIAL FATIGUE MACHINE CAPABLE OF FAST CYCLIC HEATING AND LOADING
H. P. van Leeuwen and Mahmut C. Mucuoğlu Sept. 1961 105 p 59 refs
(AGARDograph-66, Amended)

The object of the report was to investigate the requirements for an axial fatigue machine, capable of fast cyclic heating and loading. In order to evaluate the usefulness of existing equipment, various types of axial fatigue machines were studied with regard to the drive system, load capacity, frequency, and accuracy. Additional studies concerned fast heating and cooling methods and their compatibility with the machines. Suggestions are made for modifications of existing equipment. Various solutions, using standard equipment, are recommended. Additional problems, such as extension measurement and temperature measurement, are briefly discussed.
Author

N63-17693 Joint Parachute Test Facility, El Centro, Calif.
USAF 6511th TEST GROUP (PARACHUTE) AND US NAVAL PARACHUTE FACILITY
May 1963, (Rev.) 33 p
(FTC-TIH-63-2001)

The Joint Parachute Test Facility operated by the U.S. Navy and Air Force is described. The facility was established to develop, test, and evaluate parachutes and related assemblies, pilot escape parachute systems, aerial delivery systems for supply and cargo, parachute recovery systems for guided missiles, deceleration parachutes and related equipment for aircraft, and other retardation devices performing functions of parachutes. The joint supporting facilities described and illustrated include: materials laboratory, packing and fabrication section, instrumentation and shop facilities, data reduction facility, photographic laboratory, whirl tower, space positioning range, and water drop facilities.
M.P.G.

N63-17716 Aerospace Information Div., Library of Congress, Washington, D.C.
SOVIET LITERATURE ON PROTECTIVE STRUCTURES AND COMPONENTS. REVIEW OF LITERATURE Rept. 8
June 6, 1963 23 p 22 refs
(AID-P-63-79) OTS: $2.60 ph, $0.89 mf

A review of Soviet literature on ground-support equipment is presented. Areas covered are: (1) transport; (2) launch site (E6 accessories—gantries); (3) natural environment conditions; and (4) packaging, preservation, and storage (A2 containers).
N.E.A.

N63-17751 David Taylor Model Basin. Hydromechanics Lab., Washington, D.C.
TWO NEW HYDROMECHANICS RESEARCH FACILITIES AT THE DAVID TAYLOR MODEL BASIN
W. F. Brownell Dec. 1962 78 p 9 refs Presented at the Soc. of Naval Architects and Marine Engr. Chesapeake Sect. Meeting, David Taylor Model Basin, Dec. 5, 1962
(DTMB-1690)

The 36-Inch Variable-Pressure Water Tunnel and the Harold E. Saunders Maneuvering and Seakeeping Facilities at the David Taylor Model Basin are described. The information presented includes the development, construction, and use of these test facilities.
Author

N63-17760 Weapons Research Establishment (Australia)
A DESIGN PROPOSAL FOR A SUPERSONIC-HYPERSONIC WIND TUNNEL UTILISING THE W.R.E. BLOWDOWN FACILITY
B. G. Roberts May 1963 25 p 8 refs
(Tech. Note HSA-85)

A proposal is presented for extending the performance of the W.R.E. blowdown facility from M = 4, by adding a hypersonic leg, and low-pressure exhaust requirements made. The performance of each section of the tunnel is examined in detail.
Author

N63-17824 Royal Aircraft Establishment, Farnborough (Gt. Brit.)

ROCKET SLED, GROUND-LAUNCHED ROCKET AND FREE-FALLING BOMB FACILITIES

W. G. Molyneux *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Elasticity Part IV Experimental Methods [1960] p 277-292 8 refs (See N63-17815 16-33)

The use of rocket sled, ground launched rocket, and free-falling bomb facilities to obtain aeroelastic data on models of aircraft structures is described. These facilities are used in those cases where the design of the wind tunnel itself poses unacceptable limitations on the design of the aeroelastic model. Each of these alternate facilities, together with the associated methods for obtaining velocity measurements, is described. The relative merits of rocket sled, rocket, and bomb facilities are discussed in comparison to the wind tunnel facility. In designing models for use with these facilities, the twisted or cambered sections are usually replaced by uncambered sections; and, in general, model aircraft components rather than complete model aircraft are tested. The analysis of the resulting records is also discussed. Since the flutter observed usually occurs under transient conditions, the correct interpretation of the effects of Mach number, dynamic pressure, and high longitudinal acceleration is especially important. M.P.G.

N63-18031 Training Center for Experimental Aerodynamics, Rhode-Saint-Genèse (Belgium)

THE INTERMITTENT HYPERSONIC WIND TUNNEL H-1

R. H. Korkegi Mar. 1963 38 p 9 refs
(Contract AF 61(052)-289)
(TCEA-TM-15)

This note describes the 12cm × 12cm intermittent hypersonic wind tunnel H-1, its operation, and its instrumentation. With a Mach-number range from 4 to 8, the tunnel operates at stagnation pressures up to 35 atm and stagnation temperatures up to 500° C, with diffuser suction provided by a supersonic ejector. Air is supplied by two high-pressure air reservoirs with a combined capacity of $60m^3$ at 40 atm, and is heated by means of a storage heater consisting of a bed of 2 tons of ferrosilicon pebbles. The wind-tunnel instrumentation includes a Schlieren optical system which can scan the complete test section and diffuser, and fast-response pressure and temperature measurement and recording equipment. Author

N63-18062 Weapons Research Establishment (Australia)

MEASUREMENT OF THE PERFORMANCE LIMITS OF WIND TUNNEL S1

J. A. Rein Apr. 1963 24 p 6 refs
(HSA-81)

Tests were made to determine the performance limits of the Weapons Research Establishment's supersonic wind tunnel, S1, over the complete range of Mach number attainable, with an empty working section, and with the incidence change gear and a model installed in the working section. These tests were also used to investigate the effect on the performance limits of varying: (1) the model incidence and (2) the adjustable convergent-divergent diffuser throat opening. The pressure ratios required to maintain given Mach numbers have been compared with values obtained from other wind tunnels. Author

N63-18104 Directorate of Engineering Test, Aeronautical Systems Div., Wright-Patterson AFB, Ohio

THE HIGH TEMPERATURE HYPERSONIC GASDYNAMICS FACILITY— MACH NUMBER 4 OPERATION [Final Report, Aug. 1961-May 1962]

Paul Czysz May 1963 39 p 23 refs
(ASD-TDR-63-236)

The High Temperature, Hypersonic Gasdynamics Facility was developed as a result of the efforts to extend the state-of-the-art in hypersonic aerodynamics simulation. The High Temperature Facility is an operational hypersonic wind tunnel supplied by high-pressure, heated air from a zirconium oxide pebble heater. The maximum stagnation pressure is 40 atmospheres, and the maximum temperature is 4700° R. This report describes its operation from August 1961 until May 1962, as a Mach 4 aerodynamic test facility. The successful operation of this facility is a significant achievement in the area of hypersonic aerodynamic testing techniques. Author

N63-18106 Directorate of Engineering Test, Aeronautical Systems Div., Wright-Patterson AFB, Ohio

CORRELATION OF WIND TUNNEL BLOCKAGE DATA [Final Report, Sept. 1961-May 1962]

Paul Czysz Apr. 1963 30 p 14 refs
(ASD-TDR-63-230)

An experimental investigation of the test-section flow-blockage characteristics was conducted at Mach 4 in the High Temperature Hypersonic Gasdynamics Facility. The models utilized in this program were pointed and blunted cones from 5-degree half-angle to 90-degree half-angle, flat plates, delta winged shapes, and hemispherical models, some of which were run up to 40-degree angle-of-attack. Comparison of the data with other facilities resulted in a correlation of the maximum model size compared to the potential flow core size with Mach number and drag coefficient, for both open and closed test-section configurations, for Mach numbers from 1.5 to >10. Author

N63-18150 Stanford U. Stanford Linear Accelerator Center, Calif.

TWO-MILE ACCELERATOR PROJECT Quarterly Status Report, 1 Oct. to 30 Dec. 1962

Mar. 1963 88 p refs
(Contract AT(04-3)-400)
(SLAC-10) OTS: $2.00

The current status on the Two-Mile Accelerator Project is outlined as follows: Mark IV installation (modulator and klystron), accelerator structures, beam dynamics, microwave engineering, injection system, klystron studies, high-power klystron windows, modulator studies, mechanical engineering, control system studies, accelerator research, and plant engineering. R.C.M.

N63-18166 Smithsonian Astrophysical Observatory, Cambridge, Mass.

OPTICAL SATELLITE TRACKING PROGRAM Semi-annual Progress Report No. 7, July 1 through Dec. 31, 1962

Fred L. Whipple [1962] 33 p
(NASA Grant NsG-87-60)
(NASA CR-50225) OTS: $3.60 ph, $1.19 mf

Progress is reported for the following: (1) photographic tracking stations, (2) the visual observing program, (3) research and analysis, (4) the computations division, (5) the photoreduction division, and (6) communications. Also, a list of special reports prepared by the satellite tracking program is presented. I.v.L.

11 FLUID MECHANICS

Includes: boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow, 03 Aerodynamics of Wings and Control Surfaces; 13 Heat Transfer; and 24 Physics, Plasma.

N63-17488 California U., Berkeley. Lawrence Radiation Lab.
LONGITUDINAL DISPERSION IN PACKED EXTRACTION COLUMNS
Alphonse Hennico, Gabriel Jacques, and Theodore Vermeulen Mar. 18, 1963 198 p 90 refs
(Contract W-7405-eng-48)
(UCRL-10696) OTS: $2.75

Axial dispersion in packed beds has been investigated with particular reference to extraction-tower design. A new model for dispersion behavior, based upon "segmented laminar flow," is derived for analysis of breakthough curves at low flow rates; its applicability is discussed in comparison with other theoretical models of mixing. Axial dispersion coefficients in single-phase flow were measured by a step-input method over a wide range of Reynolds numbers (3 to 2000). For two-phase countercurrent flow of water and kerosene, axial-dispersion coefficients were measured for the continuous phase; they were also measured for the dispersed phase, both where the current does and does not wet the packing material. Author

N63-17512 James Forrestal Research Center, Princeton U., N.J.
MOLECULAR BEAMS FROM NOZZLE SOURCES Technical Report
John B. Fenn and Jacques Deckers June 1962 38 p 8 refs
Presented at the Intern. Symp. on Rarefied Gas Dynamics, Paris, June 26–30, 1962
(Contract Nonr-1858(25); Proj. Squid)
(PR-104-P)

A high-intensity molecular-beam apparatus has been built and operated. It is based on the suggestion that supersonic flow into the first defining orifice should result in much higher intensities and much narrower velocity distributions than can be obtained by classical effusive sources. Performance of this system is reviewed and compared with theory. An attempt is made to explain the marked deviations from theory which occur under some conditions. A model is developed which is at least consistent with observed performance and which should be useful in the design and use of such systems. Possible applications of nozzle beams are outlined. Some interesting implications of small-scale low-density flow are noted. Author

N63-17524 Delaware U., Newark
A FLOW METHOD FOR MEASURING TRANSPORT PROPERTIES AT FLAME TEMPERATURES Technical Report
George Ember, J. R. Ferron, and Kurt Wohl Charlottesville, Va. U. School of Engineering and Applied Science, Apr. 1963 38 p 9 refs Submitted for Publication
(Contract Nonr-3623(00); Proj. Squid)
(DEL-13-P)

An apparatus is described which has been used at room temperature and at 1000° to 1700° K for measurements of self-diffusivities and binary diffusivities of certain gases. The technique involves measurement of the diffusion of radioactive tracer gas released from a simulated point source into a vertical, laminar gas stream. The hot gas is produced by a flat flame which burns at the base of the apparatus. Performance of the system is illustrated by results obtained at one atmosphere for the system CO_2–CH_4 at 297° K and for the system CO_2–H_2O at 975° to 1616° K. Author

N63-17529 Aerospace Corp. Labs. Div., El Segundo, Calif.
MAGNETIC INSULATION EXPERIMENTS WITH A TRAVELING MAGNETIC PISTON
Glenn C. Light May 8, 1963 39 p 12 refs
(Contract AF 04(695)-169)
(TDR-169(3210-05)TN-2; SSD-TDR-63-72)

This paper reports on further experimental work on a traveling magnetic-piston plasma accelerator. This accelerator produces a shock wave traveling at 1.1×10^7 cm/sec. In an attempt to inhibit the flow to the boundary layer, a uniform axial magnetic field was put on the shock tube. This applied magnetic field also alters the piston shape as well as the plasma leakage through the piston. It is difficult to determine from preliminary experiments which effect is responsible for the observed changes in the flow; nevertheless, the experimental data are interesting. These data indicate that for certain orientations and strengths of axial magnetic field, the attenuation of shock-wave velocity beyond the exit of the accelerator is markedly reduced. Experimental data taken with streak camera and Kerr Cell are shown. Author

N63-17535 Princeton U., N.J.
A GENERAL THEORY FOR THE FLOW OF WEAKLY IONIZED GASES
S. H. Lam Apr. 1963 49 p 9 refs
(Grant AF-AFOSR-112-63)
(Rept. 644; AFOSR-4662)

A general theory is developed for the flow of a weakly ionized gas about arbitrary solid body or bodies with absorbing surfaces. The main interest lies in the prediction of the electrical response on the body surface as a function of the pertinent properties of the flow. The theory is based on continuum formulation, and is valid when (1) the mean-free-path of the charged particles is at most the order of a Debye length and (2) the Debye length is much smaller than the thickness of the boundary layer adjacent to the body surface. The entire range of flow velocity in terms of an electric Reynolds number R is investigated, but the detailed analysis is devoted to the case $R^{-1/2} \ll 1$. It is found that the electrical disturbances can be divided distinctly into three physically distinct but mathematically uncoupled regions, namely, the outer region, the ambipolar diffusion region, and the sheath region. Closed-form analytical results are obtained for the floating potential and the current-voltage characteristic. These are useful in the interpretations of Langmuir probe data. Detailed structures of the solutions are given in terms of explicit universal functions. Author

N63-17536 Brown U. Div. of Applied Mathematics, Providence, R.I.
INVISCID MODES OF INSTABILITY IN SPIRAL FLOW
E. T. Y. Lee and W. H. Reid May 1963 28 p 10 refs
(Contract Nonr-562(07))
(Tech. Rept. 52)

The stability of an inviscid fluid between rotating cylinders with an axial flow is considered under the small-gap approximation. When the axial flow is small compared to the rotational velocity, a new perturbation method differing in several respects from the conventional method has been devised. It is found that the presence of the axial flow has a stabilizing effect, and that the correction to the growth rates of the pure rotation case is of second-order in the axial to rotational velocity ratio. Furthermore, the instabilities are confined to only a finite range of wave numbers. Author

N63-17539 Princeton U., N.J.

COMPRESSIBLE FLOW OF AN AIR-WATER MIXTURE THROUGH A VERTICAL TWO-DIMENSIONAL, CONVERGING-DIVERGING NOZZLE **Technical Report**

J. F. Muir and R. Eichhorn Charlottesville, Va. U. School of Engineering and Applied Science, Apr. 1963 37 p 13 refs For Presentation at the 1963 Heat Transfer and Fluid Mech. Inst., June 12–14, 1963
(Contract Nonr-3623(00); Proj. Squid)
(PR-105-P)

The physical system reported on in this paper is that of the flow of a gas-liquid mixture (specifically air-bubbles dispersed in water) through a convergent–divergent nozzle under an overall pressure ratio sufficient to choke the flow at the nozzle throat. In all the results, the throat pressure was held at about one atmosphere. The parameters varied were the air–water mass ratio (to achieve values of the throat volume flow fraction ranging approximately from 0.1 to 0.8), the upstream pressure, and the overall pressure ratio. The experimental pressure ratios and velocities are presented as functions of mass and volume ratios, and compared with values predicted by existing homogeneous mixture theory. In general, agreement between experiment and theory is best for the range of mixtures having flow patterns that most closely approximate a homogeneous mixture model. Bubble velocities in the throat of the nozzle were determined from high-speed motion pictures, and are compared with mean mixture velocities calculated from the equation of continuity by treating the mixture as a single fluid. The measured bubble velocities were found to be roughly 20% higher. The effect on nozzle pressures of variations in nozzle-exit pressure was studied. At each flow condition, as the exit pressure was increased from its minimum value, a normal shock was observed to move through the divergent section from the exit to the throat. Author

N63-17551 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THE PROPAGATION OF PLANE ACOUSTIC WAVES IN A RADIATING GAS

Barrett Stone Baldwin, Jr. (Ph.D. Thesis–Stanford U.) Washington, NASA, 1962 58 p 35 refs
(Supported by NSF Grant)
(NASA TR R-138) GPO: $0.55

A study is made of the interaction of thermal radiation with fluid flow in the acoustic approximation. The analysis is developed for the case of a frequency-dependent absorption coefficient of a gas in thermal equilibrium and for quasi-equilibrium radiation. A previously given solution for the case of sinusoidal variations in position of an adjacent wall is used in superposition to find the response for an impulsive motion of the wall. Results are also given for the response to a sudden temperature change of a fixed wall. The validity of the linear approximation of the original nonlinear equations is investigated. The validity of other approximations, used in the derivations, is also examined. Author

N63-17575 Aeronautical Research Labs., Melbourne (Australia)

THE INTERACTION OF A REFLECTED SHOCK WAVE WITH THE LAMINAR BOUNDARY LAYER IN A SHOCK TUBE

R. E. Center (Sydney U.) Aug. 1962 18 p 7 refs
(ARL/A-204)

The interaction between a reflected shock wave and the laminar boundary layer caused by the incident shock wave was examined experimentally in a straight shock tube. Boundary-layer separation and shock bifurcation predicted under some conditions by the theoretical model of Mark and others, and subsequently observed by optical techniques, were detected with a thin-film resistance thermometer and piezoelectric pressure transducers. The theoretical separation criterion was tested by the employment of air and argon as the test gases. Author

N63-17595 Purdue U. Jet Propulsion Center, Lafayette, Ind.

AN ANALYSIS OF THE EFFECTS OF GAS-PARTICLE MIXTURES ON THE PERFORMANCE OF ROCKET NOZZLES

J. D. Hoffman Jan. 1963 187 p 27 refs
(JPC-348; TM-63-1)

Two-phase flow of gas-particle mixtures in rocket nozzles was investigated from a theoretical standpoint, and the governing equations for one-dimensional, two-dimensional, and axisymmetric flow were derived. The characteristic equations for the system were found and put into finite difference form. A numerical solution technique was developed and programed for the IBM-7090 computer. A method was developed for determining the subsonic flow field based on a one-dimensional sink flow approximation. The transonic flow-field solution was approximated by a power-series solution of the linearized system equations for constant kinetic and thermal lags of the particles. The supersonic flow field was solved by the method of characteristics. The subsonic, transonic, and supersonic solutions were integrated into a computer program so that the effect of combustion-chamber conditions and nozzle contour upon nozzle performance can be determined. Several trial cases were analyzed with the computer program, and the calculated results were compared with those from actual motor firings. On the basis of that comparison, it was concluded that the present analysis is a reasonable representation of the flow of gas-particle mixtures in rocket nozzles. Author

N63-17599 Brown U. Div. of Applied Mathematics, Providence, R.I.

ON THE SOLUTIONS OF THE DIFFERENTIAL EQUATION $y^{vi} = xy$. I. ANALYSIS **Technical Report No. 44**

R. L. Duty and W. H. Reid May 1963 26 p 6 refs
(Contract Nonr 562(07))

The differential equation $y^{vi} = xy$ plays an important role in the asymptotic treatment of the stability of viscous flow between contrarotating cylinders and, in one limiting case, solutions of this equation are required that remain bounded as $x \to +\infty$. A set of standard solutions have therefore been defined such that three of them, denoted by $A_k(x)$, are bounded as $x \to +\infty$, while the remaining three solutions, denoted by $B_k(x)$, are unbounded as $x \to +\infty$. The contour integral representations of these solutions are given, together with their power series and asymptotic expansions. It is also shown that a slightly modified set of these solutions provides a numerically satisfactory set over the entire interval $-\infty < x < +\infty$. Author

N63-17601 Aberdeen Proving Ground. Ballistic Research Labs., Md.

PARTIALLY CONSTRAINED IMPINGING JETS

John H. Giese Apr. 1963 17 p
(BRL-1202)

Qualitative explanations of the motion of shaped charge liners have been based on impact of two plane jets in which the moving fluid is surrounded by four stagnant regions, all at the same pressure. Actually, the motion is initiated by the difference between the high pressure in the detonation products on one side of the liner and atmospheric pressure on the other. This report considers symmetrical impact of two jets, each partially constrained on one or both sides, in which the stagnant regions are not all at the same pressure. Author

N63-17662 Minnesota U., Minneapolis
A THEORETICAL SURVEY OF CHARGED-PARTICLE RECOMBINATION PROCESSES IN GASES Technical Report No. 4
Moustafa Mosharrafa Jan. 1963 55 p 40 refs
(Contract Nonr-710(37); Proj. DEFENDER)

A survey is given of the theories applicable to the various recombination mechanisms. Both electron-ion and ion-ion recombination processes are dealt with. The theories involved, which are outlined only, are grouped into two parts, i.e., those applied at pressures below one atmosphere and those applied at higher pressures. The relation between the type of recombination process and the dependence of the recombination coefficient on the plasma parameters is discussed. The influence of the environmental conditions on the dominancy of a specific type of recombination process is illustrated. Author

N63-17677 Aerospace Corp. Aerodynamics and Propulsion Research Lab., El Segundo, Calif.
CHEMICALLY FROZEN BOUNDARY LAYER WITH SURFACE REACTIONS BEHIND A STRONG MOVING SHOCK
P. M. Chung Nov. 16, 1962 35 p 21 refs
(Contract AF 04(695)-169)
(TDR-169(3230-12)TN-3; SSD-TDR-62-164)

Surface recombination of dissociated atoms is studied behind a strong shock moving into a stationary diatomic gas. The chemically frozen laminar boundary layer is analyzed behind the moving shock. A solution is obtained for surface distribution of atoms and heat transfer when the atom concentration varies arbitrarily in the inviscid dissociating gas stream and, at the same time, the surface has an arbitrary but uniform catalycity. The applicability of the theory to the chemical diagnostics of shock tubes is studied. Author

N63-17679 Princeton U., N.J.
THE EFFECTS OF ROTATION ON THE STABILITY OF LAMINAR BOUNDARY LAYERS ON CURVED WALLS
Peter W. Conrad Aug. 1962 48 p 9 refs
(FLD-9)

A study is made of the stability, relative to small disturbances, of boundary layers over slightly curved walls which are rotating about an axis perpendicular to both the flow direction and the radii of curvature. The primary interest is in the neutral stability case (no amplification) for which an eigenvalue problem is developed which will yield a critical Reynolds number for each combination of rotation, curvature, and frequency of the disturbance. Results are given for various intermediate frequencies, along with a limiting value for the zero-frequency case and a qualitative argument concerning the trend for high frequencies, for several combinations of curvature and rotation. Author

N63-17685 Avco-Everett Research Lab., Everett, Mass.
INVESTIGATION OF THE EFFECTS OF HIGH INTENSITY ELECTROMAGNETIC WAVES ON THE TRANSPORT PROPERTIES AND PHENOMENA OF IONIZED GAS AT ELEVATED TEMPERATURES Final Report
Apr. 1963 60 p 16 refs Includes abstracts of reports prepared under this contract
(Contract AF 19(604)-7458)
(AFCRL-63-127)

The research work performed is briefly summarized and reviewed. A complete list of scientific reports and papers published during the research is also given. Author

N63-17704 Sandia Lab., Albuquerque, N. Mex.
VISCOUS FLOW PAST A ROTATING TRANSLATING BLADE WITH ARBITRARY VELOCITY SUCTION AND SLIP
K. J. Touryan May 1963 62 p 22 refs
Supported by AEC
(SC-4777(RR)) OTS: $1.50

The three-dimensional flow of a viscous fluid over a rotating translating blade with arbitrary suction applied at the wall is studied. Velocity slip is included as a boundary condition to account for rarefaction effects. Pressure drops are estimated across the blade and the flow patterns studied in the capillaries of the blade wall (filter media). A feasibility study is made for using such a blade as a sampling device on the SAND program. Author

N63-17727 Office of Research Analyses, Holloman AFB, N. Mex.
GAS DYNAMIC ASPECTS OF AN ENCLOSED HYPERSONIC TEST TRACK
Raymond P. Holland, Jr. May 1963 87 p 9 refs
(ORA-63-9)

The gas dynamics related to the movement of a track-guided test vehicle through an evacuated tube are considered preliminarily. Values of pressure, temperature, density, and drag are computed for perfect piston action and for partial piston action at speeds up to the hypersonic. The effects of gas imperfections, viscosity, and wave-reflection are explored. The limiting conditions at which a body in a tube ceases to behave like a piston are defined. At the lower limit of piston action, pressures, temperatures, and densities ahead of the vehicle are the same as for a flat-faced body in free air, and skin-friction effects along the tube wall are negligible. At the upper limit of piston action, pressures in frictionless air range from about 44 percent greater (above Mach 8.0) to more than 80 percent greater (below Mach 2.0) than at the lower limit of piston action, and drag and heating due to friction predominate over shock effects; frictional heating, in particular, becomes large. The relative effects of piston action as compared to flow in free air are greater at low Mach numbers than at high Mach numbers. Pressures are ample at all speeds for effective braking by piston action, but high temperatures exist at all but the lowest speeds. Author

N63-17756 Battelle Memorial Inst., Columbus, Ohio
EXPERIMENTAL DETERMINATION OF THE VISCOSITY OF AIR IN THE GASEOUS STATE AT LOW TEMPERATURES AND PRESSURES Technical Documentary Report [June 12, 1961-Dec. 11, 1962]
Daniel R. Grieser and William H. Goldthwaite Arnold Eng. Devel. Center, June 1963 26 p 11 refs
(Contract AF 40(600)-938)
(AEDC-TDR-63-143)

A program was undertaken to determine the viscosity of gaseous air at cryogenic temperatures for use in the interpretation of hypervelocity wind-tunnel data. Data were obtained over a temperature range of 92.7 to 198.0 R, using an oscillating-disk viscosimeter designed for cryogenic operation. Data were also obtained at greatly reduced pressures where the slip effect becomes important. This was done to aid in the evaluation of the lowest temperature data, where reduced pressures were mandatory in order to avoid condensation. Author

N63-17761 Aberdeen Proving Ground. Ballistic Research Labs., Md.
A PHOTOGRAMMETRIC METHOD FOR DETERMINING THE TOPOGRAPHY OF LIQUID SURFACES
Heinz G. Poetzschke and Donald F. Menne Mar. 1963 32 p
(Partially supported by Harry Diamond Labs.)
(BRL-1196)

A stereophotogrammetric method has been developed for the determination of the topography of liquid surfaces, which serve as an analog for gas pressures and velocities in the evaluation of turbine performance. An instrumentation system has been constructed, consisting of two modified wild RC-7 cameras with microflash projection of a random pattern of spots to identify the water table surface. The reduction of the data was accomplished by both analog and analytical methods. The analog method, including automatic plotting, was the more economical and yielded an accuracy of ±120 microns. The analytical method, involving manual plotting, resulted in an overall accuracy of ±60 microns, and an accuracy of ±30 microns for small areas near the center. Author

N63-17764 Advisory Group for Aeronautical Research and Development, Paris (France)

THE STUDY OF SUBSONIC, SUPERSONIC, AND HYPERSONIC FLOWS BY THE METHOD OF HYDRAULIC ANALOGY [METHODES D'ÉTUDE, PAR ANALOGIE HYDRAULIC, DES ÉCOULEMENTS SUBSONIQUES, SUPERSONIQUES ET HYPERSONIQUES]

H. Werlé Oct. 1960 52 p 42 refs In FRENCH; ENGLISH abstract Presented at the Meeting on Industrial Utilization of Wind Tunnels, AGARD Fluid Dynamics Work Group, Istanbul, Oct. 3–8, 1960

(AGARD-399)

The present report reviews the characteristics and uses of a number of hydraulic devices, in particular, those used in the Hydraulic Analogy Laboratory of the Aerodynamics Department of O.N.E.R.A. These devices are: hydrodynamic tunnel, supersonic tank ($\gamma = 2$), hypersonic analogy assembly, etc. These items of equipment are used for visualization of the flow around models by means of suitable methods. They have made it possible, in a large number of cases, as shown by the results quoted by way of example, to make a qualitative, or even quantitative contribution to aerodynamic research work carried out by other means. Author

N63-17774 Cornell U. Graduate School of Aerospace Engineering, Ithaca, N.Y.

CURRENT-LAYER DIFFUSION IN A ONE-DIMENSIONAL MAGNETIC PINCH

Theodore J. Falk June 1963 113 p 30 refs

(Contract AF 49(638)-544)

Diffusion of the current layer at the surface of a compressible electrically conducting gas is analyzed in the case of a one-dimensional pinch. Results are presented for three values of the ratio of thermal-diffusion length to magnetic-diffusion length, the values ranging from greater than one to much less than one. The gas boundary is found to be displaced from its infinite-conductivity position by a distance that is of the order of magnitude of the current-layer thickness. Comparison of constant-conductivity results with temperature-dependent-conductivity results shows that the temperature dependence significantly reduces the displacement of the gas boundary when the ratio of thermal-diffusion length to magnetic-diffusion length is small. The second solution obtained represents the initiation of the pinch, the limit in which the inertia terms are large. The magnetic field is calculated without considering the effect of gas motion, and the gas motion is then obtained from the known driving field. With the total current chosen to vary with a power of the time, a solution is derived which consists of two parts, one valid in the immediate vicinity of the wall and the other in the portion of the current layer not influenced by the wall. Although the limiting solution is not valid over a time period of sufficient length to permit complete development of the pinch, there is some indication of an ultimate decrease in wall pressure and the onset of pinch. Author

N63-17775 Princeton U., N.J.

AN EXPERIMENTAL INVESTIGATION OF LAMINAR HYPERSONIC FLOWS. PART I: PRESSURE MEASUREMENTS

K. N. Nicoll Wright-Patterson AFB, Ohio, Aeronautical Research Labs., May 1963 48 p 12 refs

(Contract AF 33(616)-7629)

(ARL-63-73)

An experimental investigation has been made of the pressure distributions on a set of cone-models incorporating annular cavities. The cone-surface Mach number was 6.5, and all cavity flows were "open." The results indicate that a regime of laminar, open cavity flow exists at hypersonic Mach number which is characterized by the property that the cavity floor pressure is virtually constant. Recompression is confined to the last 10% of the cavity near the reattachment point. Author

N63-17863 Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson AFB, Ohio

SOLUTION OF FILM CONDENSATION PROBLEM BY SUCCESSIVE ANALYTICAL INTERATION

J. H. Lee [1963] 13 p 6 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session III-B, San Antonio, Tex., Apr. 16–19

The boundary-layer equations arising from the formulation of two-phase laminar film condensation were reduced to a set of three simultaneous integrodifferential equations, describing the velocity and temperature distributions in the condensate film and the condensate film profile. The solution was effected by successive analytical interation with the aid of a computing machine. Due to the introduction of approximate shear-stress continuity at the interface, only two parameters, $C_p\ \Delta T/\lambda$ and P_r play an important role. Linearity of temperature distribution is insignificantly disturbed regardless of the values of two parameters; however, the velocity distribution is expressed as a convergent power series which has $(C_p \Delta T/\lambda)/P_r$ as expansion parameter. Author

N63-17891 Princeton U. Frick Chemical Lab., N.J.

INFRARED EMISSION STUDIES OF VIBRATIONAL RELAXATION IN SIMPLE MOLECULES Technical Report No. 3

Peter Borrell Nov. 22, 1962 27 p 11 refs

(Contract Nonr-1858(26))

A preliminary study of infrared emission from shock-heated gases has been carried out, using a gold-doped germanium detector. These measurements gave lower limits to the transition probabilities for the uptake of vibrational energy on collision, but the correct values are certainly no more than double those quoted. The values obtained in the vicinity of 1000° K are: HCl, 3×10^{-5}; HBr, 2.3×10^{-5}; $CO_2(\nu_3)$, 2.1×10^{-5}; and $N_2O(\nu_3)$, 1.8×10^{-5}. Author

N63-17892 Aerospace Corp. Aerodynamics and Propulsion Research Lab., El Segundo, Calif.

GENERALIZED LAMINAR BOUNDARY LAYER IN THREE-DIMENSIONAL FLOW

S. W. Liu Sept. 1, 1962 42 p 26 refs

(Contract AF 04(695)-169)

(SSD-TDR-62-101; TDR-169(3230-12)TN-1)

A new approach to the three-dimensional boundary-layer problems is proposed. The similarity concept is generalized for three-dimensional laminar flows whenever more than one velocity component exists in the inviscid flow field immediately outside of the boundary layer. For each boundary layer, flow component similarity is established separately, each appropriate to the nature of the corresponding inviscid velocity component at the outer edge. For the purpose of solving simultaneous differential equations, a single independent variable can be adopted, which is considered merely as a mathematical convenience. Two examples are chosen with which derivations are presented for compressible flow using the proposed scheme. They are the general blunt-body stagnation point flow and the stagnation line flow of a supersonic cone at angle-of-attack. It has been demonstrated by the examples that consistent formulation can be obtained without the restriction of a single similarity variable. By comparison, formulations of the same problems based on a single similarity variable are constrained to the flow component upon which the similarity is based, and such formulations are consistent only when this component is the predominant one of the problem. The present formulation, when applicable, is therefore expected to produce results of more general validity in three-dimensional flow problems.

Author

N63-17961 General Dynamics Corp. John Jay Hopkins Lab. for Pure and Applied Science, San Diego, Calif.

ELECTRON COLLISIONS WITH ATOMIC AND MOLECULAR OXYGEN

W. L. Fite and R. T. Brackmann June 18, 1963 21 p 12 refs
Presented at the Sixth Intern. Conf. on Ionization Phenomena in Gases, Paris, July 8–13, 1963
(Contract DA-49-146-XZ-041)
(GA-4313)

The production of positive and negative ions in electron collisions with atomic and molecular oxygen was examined through mass-spectrometric monitoring of beams issuing from RF gas discharges and a thermal dissociation furnace. Detection of both electronically and vibrationally excited molecules was made through positive ionization. Some details of the threshold ionization of ground state atomic oxygen are also presented. It was found that production of O^- in electron collisions with excited O_2 is enhanced over the case involving ground state O_2, and dissociative attachment seems to be shifted downward by approximately 2 ev in incident electron energy. Ionization efficiency curves near threshold are given for several inert-gas-excited metastable atoms. Author

N63-18059 Cornell U. Graduate School of Aerospace Engineering, Ithaca, N.Y.

ON THE PROPAGATION OF SMALL AMPLITUDE WAVES IN MAGNETO-GASDYNAMIC CHANNEL FLOWS

Stanley G. Rubin June 1963 114 p 22 refs
(Grant AF-AFOSR-62-201)

The asymptotic behavior of small unsteady perturbations, which are superposed on an equilibrium magnetogasdynamic channel flow, is considered. Two geometries are treated; the so-called "crossed-fields" channel, where the applied magnetic field and velocity field are perpendicular to each other, and the "aligned-fields" configuration, where the magnetic and velocity fields are parallel. A set of "quasi-one-dimensional" equations is obtained. From the resulting set of hyperbolic equations, the theory of characteristics provides certain compatibility relations which describe the behavior of small disturbances of the steady channel flow, which are caused by some local pressure fluctuation. Two distinct wave motions are present within the channel, and the asymptotic behavior of both is examined with the use of the compatibility relations. It is shown that under certain conditions, on the magnetic-field distribution, wave motions which lead to shock formation in ordinary gasdynamic flow will attenuate, due to the action of the magnetic field.

Author

N63-18081 New York U. Courant Inst. of Mathematical Sciences, N.Y.

DIRECT-INTERACTION APPROXIMATION FOR A SYSTEM OF SEVERAL INTERACTING SIMPLE SHEAR WAVES Research Report No. 1

Robert H. Kraichnan June 1963 25 p 10 refs
(Contract Nonr-399(00))

The direct-interaction approximation is applied to the evolution in time of systems of several interacting inviscid simple shear waves whose initial amplitudes have a gaussian statistical distribution. The results are compared numerically with exact statistical solutions obtained by numerical integration of the equations-of-motion of the wave amplitudes for a large set of initial conditions. It is found that the direct-interaction results can provide an adequate approximation in cases where both perturbation theory and the quasi-normality approximation give physically unacceptable results. Author

N63-18105 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.

INVISCID, NONEQUILIBRIUM FLOW BEHIND BOW AND NORMAL SHOCK WAVES. PART I. GENERAL ANALYSIS AND NUMERICAL EXAMPLES

Paul V. Marrone May 1963 113 p 48 refs
(Contract DA-30-069-ORD-3443; ARPA Order 253-62)
(CAL-QM-1626-A-12(I))

This report discusses the thermodynamic and chemical kinetic models for a complex reacting mixture of ideal gases. The inverse method, which is used to compute the nonequilibrium flow around the nose of a blunt, hypersonic vehicle, is presented in detail. The effect of vibrational nonequilibrium and vibration-dissociation coupling on the chemical relaxation zone is shown for both normal and bow shock waves. Several numerical examples are given to illustrate the nonequilibrium shock-layer flow around a blunt-nosed, hypersonic vehicle.

Author

N63-18107 Ohio State U. Aerodynamic Lab., Columbus

AN EXPERIMENTAL INVESTIGATION OF THE SURFACE PRESSURE AND THE LAMINAR BOUNDARY LAYER ON A BLUNT FLAT PLATE IN HYPERSONIC FLOW. VOLUME I. SURFACE PRESSURE DISTRIBUTIONS ON A BLUNTED FLAT PLATE [Final Report, Jan. 1961–Aug. 1962]

G. M. Gregorek, T. C. Nark, and J. D. Lee Wright-Patterson AFB, Ohio, Flight Dynamics Lab., Mar. 1963 114 p 5 refs
(Contract AF 33(616)-7827)
(ASD-TDR-62-792, Vol. I)

Pressures were measured over the surface of an unswept blunt flat plate, having a cylindrical leading edge 1/2-inch in diameter. The flat plate was side-mounted in the ALOSU 12-inch continuous hypersonic wind tunnel. Separate tests were conducted with cylinders in order to obtain detailed data for the leading edge. Stagnation temperatures were sufficiently high to eliminate condensation effects. The leading-edge and cylinder pressure ratios were noted to be independent of both Mach number and Reynolds number. The flat-plate pressure ratios show a small dependence on Mach number. Reynolds-number effects on the plate pressure ratios were small, except at the lower levels of Reynolds number, where the interaction of the thickened boundary layer caused increases in pressure.

Author

N63-18110 General Dynamics/Convair, San Diego, Calif.

FLAPPED HYDROFOILS IN WAVES, SUBCAVITATING FLOW Technical Report

A. C. Conolly May 1963 130 p 14 refs
(Contract Nonr-3180(00))
(GDC-63-032)

This report presents tank test data for a rectangular flapped hydrofoil mounted to the carriage by a single strut. Tests were carried out separately with flaps oscillating in smooth water, flaps fixed in regular waves, and then various combinations of conditions with flaps oscillating in regular waves. The separate effects of flap and wave on the force and moment coefficients for the hydrofoil were obtained, and compared with the results when both flap and wave were cycled together. Author

N63-18139 California Inst. of Tech., Pasadena

I. DESIGN AND APPLICATION OF PIEZOCERAMIC TRANSDUCERS TO TRANSIENT PRESSURE MEASUREMENTS. II. SOME MEASUREMENTS OF CURVATURE AND THICKNESS OF REFLECTING NORMAL SHOCKS AT LOW INITIAL PRESSURES Progress Report, Nov. 1, 1961–May 1, 1962

Douglas S. Johnson 1962 97 p 27 refs
(NASA Grant NsG-40-60)
(NASA CR-50495) OTS: $8.60 ph, $3.11 mf

A small pressure transducer, using the piezoelectric properties of a manufactured ceramic, was designed, constructed, and installed in the end plate of the GALCIT 17-inch shock tube to obtain high-speed measurements of the pressure field behind a reflecting shock. The design problem for piezoceramic pressure transducers, and some possible solutions are discussed in detail. Results of transducer calibration and recommendations for improvement of the instrument are presented. An initial program to determine the curvature of a shock at low initial pressures was run concurrently with calibration of five of the above pressure transducers. The results of this program are described. At an initial pressure of 30 microns in the GALCIT 17-inch tube, the shock obtained at a Mach number of about 7.5 in argon is observed to have a total curvature of approximately 10 millimeters, or approximately two percent of the tube diameter. The shock thickness observed under these conditions is approximately 5 millimeters. Author

N63-18200 California Inst. of Tech. Hydrodynamics Lab., Pasadena

A WAKE MODEL FOR FREE-STREAMLINE FLOW THEORY. PART II. CAVITY FLOWS PAST OBSTACLES OF ARBITRARY PROFILE

T. Yao-tsu Wu and D. P. Wang May 1963 49 p 24 refs
(Contract Nonr-220(35))
(Rept. 97-4)

In Part I of this paper, a free-streamline wake model was introduced to treat the fully and partially developed wake flow or cavity flow past an oblique flat plate. This theory is generalized herein to investigate the cavity flow past an obstacle of arbitrary profile at an arbitrary cavitation number. Consideration is first given to the cavity flow past a polygonal obstacle, whose wetted sides may be concave towards the flow and may also possess some gentle convex corners. The general case of curved walls is then obtained by a limiting process. The analysis in this general case leads to a set of two functional equations, for which several methods of solution are developed and discussed. As a few typical examples, the analysis is carried out in detail for the specific cases of wedges, two-step wedges, flapped hydrofoils, and inclined circular arc plate. For these cases, the present theory is found in good agreement with the experimental results available. Author

N63-18201 Quartermaster Research and Engineering Center, Natick, Mass.

FURTHER STUDIES OF THE JET COMPRESSOR

Harold J. Hoge and Ronald A. Segars May 1963 63 p 13 refs
(Tech. Rept. PR-9)

A description is given of the various regimes of flow that can exist in the jet compressor. A new apparatus is described, and data taken with it on 6 systems of gases (He: Freon-113, He: air, air: Freon-113, air: Freon-12, air: air, and Freon-12: air) are presented. The highest efficiency achieved with the new apparatus is 0.125, at a compression ratio of 1.590, with helium as the driven gas and Freon-113 as the driving gas. Calculations of momentum-flux balance within the jet compressor are made, with allowances for friction, and, when necessary, for flow separation within the driving-gas nozzle. The changes of available energy associated with the various processes that take place within the jet compressor are individually calculated from the experimental data. The flow rate of driven fluid is calculated as a function of inlet pressure for the system air: Freon-113, by a method proposed by Fabri and Siestrunck; the results represent the observations, but not accurately. Author

12 GEOPHYSICS

Includes: auroral phenomena; upper atmospheric studies; cartography; geodesy; and geomagnetism.

For Van Allen belts see: 28 Space Radiation.

For related information see: 05 Astronomy and Astrophysics; 21 Meteorology; and 29 Space Sciences.

N63-17484 Southwest Center For Advanced Studies, Dallas, Tex.

THEORY OF AURORAL ELECTROJETS

J. A. Fejer Nov. 7, 1962 31 p 17 refs Submitted for Publication
(NASA Grant NsG-269-62)
(NASA CR-50330) OTS: $3.60 ph, $1.13 mf

Two mechanisms are described for the formation of electrojet currents in the auroral zone. Both mechanisms require the existence of magnetospheric convection in which only particles of relatively low energy participate. It is essential to both mechanisms that particles of one sign (positively or negatively charged) should predominate among the energetic ones that do not participate in the convection of the magnetosphere. In the first mechanism, the convection of the magnetosphere is taken to be of tidal origin and is driven by the electric polarization fields associated with the dynamo current systems. In the second mechanism, the convection is assumed to be the co-rotation of the magnetosphere with the earth, as modified by the solar wind that distorts the geomagnetic field. In both mechanisms, the ionospheric currents are a consequence of the relative motion between the less energetic particles that almost fully participate in magnetospheric convection and the more energetic particles whose adiabatic drift motion across the magnetic field is only slightly perturbed by the electric fields associated with the convection of the magnetosphere. If the latter particles are assumed to be the trapped energetic protons observed by Explorer XII (Davis and Williamson 1962) during magnetically quiet days, then either mechanism predicts variations of the order of $\pm 50\gamma$ in the horizontal component of the geomagnetic field at auroral latitudes. Author

N63-17502 Columbia U. Lamont Geological Observatory, Palisades, N.Y.

FREE SPHEROIDAL VIBRATIONS OF THE EARTH AT VERY LONG PERIODS, PART I – CALCULATION OF PERIODS FOR SEVERAL EARTH MODELS

Leonard E. Alsop Repr. from Bull. Seismol. Soc. Am., vol. 53, no. 3, Apr. 1963 p 483–501 18 refs
(Contract AF 19(604)-7376; Proj. Vela Uniform)
(Lamont Geol. Obs. Contr.-606)

Periods of free vibrations of the spheroidal type have been calculated numerically on an IBM 7090 for the fundamental and first two shear modes for periods greater than about two hundred seconds. Calculations were made for four different earth models. Phase and group velocities were also computed, and are tabulated for the first two shear modes. The behavior of particle motions for different modes is discussed. In particular, particle motions for the two shear modes indicate that they behave in some period ranges like Stoneley waves tied to the core-mantle interface. Calculations have been made also for a model which presumes a solid inner core. The two computer programs which were made for these calculations are described briefly. Author

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N63-17541 Norwegian Defence Establishment, Kjeller

MEASUREMENT OF AN ELECTRON DENSITY AND COLLISION FREQUENCY PROFILE IN THE LOWER D-REGION DURING POLAR RADIO BLACKOUT CONDITIONS Technical Report

B. Bjelland, O. Halt, and B. Landmark Feb. 18, 1963 36 p 8 refs
(Contract AF 61(052)-464)
(FFIT Intern Rapport E-2; AFCRL-63-639)

A rocket range has been established at Andøya in North Norway where Nike Cajun or equivalent rockets can be fired from a zero length launcher. A comparatively simple Doppler method is used in order to measure the slant range to the vehicle as a function of time during the flight. For well-behaved rockets like the Nike Cajun such a system is considered satisfactory, although it is planned to make use of radar tracking. On 18 August 1962 the first Nike Cajun rocket was successfully fired. The purpose of the experiment was to measure electron density and collision frequency in the lower D region during polar radio blackout conditions. This experiment was carried out in cooperation with the Royal Technical University of Denmark. The method used was a combined multifrequency absorption and phase experiment. From the results, it has been possible to deduce quite a reliable electron density and collision frequency profile in the height range from about 50 km to 80 km. Author

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N63-17566 Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

UPPER ATMOSPHERE DENSITY OBTAINED FROM FALLING SPHERE DRAG MEASUREMENTS Research Report

F. S. Sherman (Calif. U.,) G. A. Faucher, and R. W. Procunier, Dec. 1962 32 p 15 refs
(AFCRL-62-1136)

A density profile vs. altitude from 95 to 130 km, obtained from drag measurements made directly from within a falling sphere, is presented. The main sensors are linear accelerometers aligned to measure X, Y, Z components of acceleration of the sphere from which total drag is obtained. The method consists of ejecting an inflatable sphere somewhere between 80 and 100 km on the ascent of an Aerobee-150 rocket flight. From ejection, the sphere continues to approximately 250-km altitude on a trajectory which is, except for drag, a free-fall trajectory. The prediction of sphere drag coefficients with their estimated probable errors is given in the altitude range from 90 to 160 km. The telemetry record showing the drag forces used in calculating the density profile in the altitude range 95 to 130 km is shown. The sources of error in the calculated density are analyzed and tabulated. The calculated density in kilograms per cubic meters vs. altitude in kilometers is compared with the ARDC Model Atmospheres of 1956, 1959 and 1961. Author

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N63-17597 Lichtklimatisches Observatorium, Arosa (Switzerland)

VERTICAL OZONE DISTRIBUTION OVER AROSA FROM SEVENTEEN MONTHS OF ROUTINE OBSERVATIONS OF THE UMKEHR EFFECT Technical Report No. 1 [March 1961–July 1962]

Hans Ulrich Dütsch (Natl. Center for Atmospheric Res., Boulder, Colo.) [1962] 63 p 6 refs
(Grants AF-EOARDC-61-18 and AF-EOAR-62-115)
(AFCRL-63-659)

Umkehr data from seventeen months (March 61–July 62) of routine observations at Arosa, Switzerland, were evaluated for vertical ozone distribution on an electronic computer. Some remaining problems of the evaluation method are discussed here. Results on vertical distribution are shown and compared with those obtained during an earlier period (1956–1959). Also some especially interesting single cases are discussed. It is found that the ozone content in the top layer (above 43 km) shows a winter maximum in accordance with the photochemical theory, but also large-scale irregular fluctuations are observed at this level. Author

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N63-17622 Physikalisch-Meteorologisches Observatorium Davos (Switzerland)

THE DIURNAL AND ANNUAL VARIATIONS OF THE SPECTRAL INTENSITY OF ULTRAVIOLET SKY AND GLOBAL RADIATION (BETWEEN 297.5 mμ AND 380 mμ) ON CLOUDLESS DAYS AT DAVOS, 1590 m a.s.l. Technical Note 2

Paul Bener Jan. 1963 82 p 9 refs
(Contract AF 61(052)-618)
(AFCRL-63-654)

The climatological features of the spectral intensity of ultraviolet sky and global radiation are presented in this paper in the form of hourly values for every month of the year. These figures relate to monthly means of atmospheric ozone and to average conditions of ground reflection and turbidity during the "winter period" (ground covered with snow) and the "summer period" (ground free from snow). Diagrams showing the diurnal variation of the intensity for various wavelengths, and its spectral distribution for different hours of the day are presented for December, March, June, and September, which months have high, medium, and low monthly means of atmospheric ozone amount. Further diagrams show the annual variation of the intensity for various hours and wavelengths. The latter curves illustrate the combined effect of the annual variation of solar declination, atmospheric ozone, and ground reflection on the intensity of ultraviolet sky and global radiation. The ratio between the vertical component of direct ultraviolet solar radiation and total diffuse radiation is examined in its diurnal and annual variation, and in dependence on wavelength. An increase of this ratio with increasing values of solar altitude and wavelength can be stated for all wavelengths between 330 mμ and 370 mμ. The influence of atmospheric ozone on this ratio is discussed. Author

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N63-17624 Pennsylvania State U. Ionosphere Research Lab., University Park

A FLEXIBLE METHOD OF DETERMINING THE ELECTRON DENSITY DISTRIBUTION IN THE IONOSPHERE

J. R. Doupnik Aug. 1, 1963 78 p 25 refs
(NSF Grant 22040)
(Scientific Rept. PSU-SR-190)

A flexible method of obtaining the distribution of electrons in the ionosphere from both top- and bottom-side ionograms is developed for the digital computer. The electron-density profile is represented by a succession of parabolas in either plasma frequency or the natural logarithm of plasma frequency, such that the profile and its slope are continuous. Scaling of the ionograms may be done anywhere because the necessary coefficients are computed as needed. On the bottom side, ordinary and extraordinary modes may be reduced independently, or they may be combined in a least-squares formulation to compensate for unseen low-lying ionization. Results are presented for several assumed profile shapes in this region. A simple and effective technique of compensating for the variation of gyrofrequency with height is developed for the top side. The effects of inaccurate data and of the number of data samples are analyzed. Author

N63-17633 Michigan U., Ann Arbor

EFFECT OF DELAY TIME AND NUMBER OF DELAYS ON THE SPECTRA OF RIPPLE-FIRED SHOTS Scientific Report No. 5

Henry N. Pollack Repr. from Earthquake Notes, v. 34, No. 1, Mar. 1963, p 1–12 1 ref
(Contract AF 19(604)-6642)
(AFCRL-63-296; Rept. 3649-16-S/3708-18-S)

Quarry operators often find it advantageous to fire multiple hole blasts with time delays between each blast. This practice, in blaster's parlance, is known as ripple firing. One effect of time delays between shots of a multiple hole blast is to impart to the seismic signal of periodicity which invites analysis by Fourier techniques. This paper investigates the effect of delay time and number of delays on the spectra of ripple-fired blasts. Author

N63-17645 Texas U. Electrical Engineering Research Lab., Austin

WIND AND TEMPERATURE IN THE ATMOSPHERE BETWEEN 30 AND 80 KM 11th Quarterly Technical Report, 1 Jan. 1963–31 Mar. 1963

D. R. Haragan and N. K. Wagner [1963] 34 p 13 refs
(Contract DA-23-072-ORD-1564)

The error in temperature as indicated by rocketsonde thermistors is analyzed in terms of the variables associated with variation in temperature of the thermistor. A differential equation is derived which includes the effects of forced convective heat transfer, radiative heat transfer, compressional heating, heat conduction along thermistor lead wires, and internal heating. Many quantities appearing in this equation can be expressed as a function of height alone, and the power dissipation can be expressed as a function of thermistor temperature. A discussion of the variables and the expressions for their variations with height and temperature are presented. Current problems in stratospheric meteorology are reviewed to evaluate those which can be investigated within the framework of the Meteorological Rocket Network. M.P.G.

N63-17646 RAND Corp., Santa Monica, Calif.

GRAVITATIONAL FIELDS OF EARTH MODELS AND THE STRUCTURE OF THE EARTH'S INTERIOR

Deanne Oberste-Lehn May 1963 15 p 8 refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-3642-PR)

The third zonal harmonic (J_3) of the earth's potential field, the value of which has been determined from the orbits of near-earth satellites, contributes a pear-shaped component to its field configuration. The cause has not been definitely established. The results of this study indicate that differences in density layering between oceanic and continental blocks may account for the third zonal harmonic, provided that the crust–upper-mantle structure has a double density-contrast crossover which results in a lower center of gravity under the continents; the depth of isostatic compensation occurs in the upper mantle at depths of at least 200 to 300 km; and the difference in seismic velocities in the low-velocity layer under oceans and continents may be due, in part, to small density differences between the two areas. Author

N63-17710 Columbia U. Lamont Geological Observatory, Palisades, N.Y.

FREE SPHEROIDAL VIBRATIONS OF THE EARTH AT VERY LONG PERIODS, PART II: EFFECT OF RIGIDITY OF THE INNER CORE

Leonard E. Alsop (NASA. Goddard Inst. for Space Studies) Repr. from Bull. Seismol. Soc. Am., v. 53, no. 3, Apr. 1963 p 503–515 19 refs
(Contract AF 19(604)-7376)
(*Its* Contribution No. 607)

Numerical calculations have been made on an IBM 7090 of the periods and particle motion with depth of the lowest order, free spheroidal vibrations of the fundamental and first two higher modes with inner-core shear velocity as a parameter. All calculations were made for a model with velocities according to Jeffreys, and with densities obeying Bullen's model B. These calculations show that the effect of the inner-core shear velocity on these periods is slight, except for those velocities at which the modes have periods near to the periods of core modes. This means that observations of long-period free vibrations will probably not give much information about rigidity of the inner core. A mode of vibration having many of the properties of the mode suggested by Slichter has been discovered. In addition, it appears that the presence of a solid inner core brings into existence many core type modes with periods both shorter and longer than the original core mode predicted by Alterman, Jarosch, and Pekeris. Author

N63-17722 General Electric Co. Technical Military Planning Operation, Santa Barbara, Calif.

TABULAR DISPLAYS OF GEOMAGNETIC GEOMETRY

Walter F. Dudziak, David C. Kleinecke, and Theodore J. Kostigen Apr. 1, 1963 183 p 23 refs
(Contract DA-49-146-XZ-109)
(RM-63TMP-3; DASA-1377)

This report contains tables presenting computational data pertaining to the geometric properties of the geomagnetic field, and a brief related theoretical description to make this material more meaningful. The tables include: (1) the values of total field intensity (B) and McIlwain's magnetic shell parameter (L) for altitudes from zero to two thousand kilometers, (2) the detailed value of total field intensity near the South Atlantic anomaly, and (3) the traces in both hemispheres of points with a fixed value of B and L. Author

N63-17741 Texas U. Electrical Engineering Research Lab., Austin

WIND AND TEMPERATURE IN THE ATMOSPHERE BETWEEN 30 AND 80 KM Ninth Quarterly Technical Report, July 1–Sept. 30, 1962

N. K. Wagner, D. R. Haragan, and J. R. Gerhardt [1962] 38 p 4 refs
(Contract DA-23-072-ORD-1564)

Wind and temperature data obtained by rocketsondes in the atmosphere between 30 km and 80 km are analyzed. The effect of the manufacturer's reported changes in the characteristics of the bead thermistors of the type used in the Meteorological Rocket Network was analyzed and found to be negligible. A least squares curve-fitting analysis was made of the ARCAS parachute fall speed in the height interval from 100,000 ft to 185,000 ft. Analyses of rocketsonde data from the fall of 1961 indicate that the seasonal transition in the circulation pattern (from easterlies to westerlies) occurs first at the upper levels of the stratosphere and propagates downward as the season advances. A synoptic case analysis made at constant pressure surfaces for November 10, 1960, of the winds and temperatures reported at White Sands, Point Mugu, Fort Churchill, and Fort Greely is presented. M.P.G.

N63-17744 National Aeronautics and Space Administration, Washington, D.C.
MICROMETEORITE PARAGLIDER EXPERIMENT News Release No. 63-102
May 13, 1963 4 p
Available from NASA. Office of Scientific and Technical Information, Wash., D.C.

An experiment designed to launch an inflatable paraglider, instrumented to gather information on the meteoroid hazards in space is described. Aerobee 150 will be the launch vehicle. The paraglider is designed to attain an altitude of from 575,000 to 600,000 feet and jettison the nose cone at 400,000 feet on descent. The paraglider experiment is intended not only to make penetration measurements in space, but to return the paraglider to earth so that impact craters and possible imbedded particles may be examined. Successful recovery of the paraglider, which would be the first atmospheric reentry of a flexible-winged vehicle, will provide information on paraglider performance during entry. D.E.R.

N63-17745 Texas U. Electrical Engineering Research Lab., Austin
WIND AND TEMPERATURE IN THE ATMOSPHERE BETWEEN 30 AND 80 KM Eighth Quarterly Technical Report, 1 Apr. 1962-30 June 1962
D. R. Haragan, N. K. Wagner and J. R. Gerhardt [1962] 40 p 4 refs
(Contract DA-23-072-ORD-1564)

Recent measurements and estimates of the infrared radiational environment of the thermistor have been employed with a more complete form of the temperature error equation. This has resulted in more reliable values of the correction factor which should be applied to rocketsonde temperature measurements. Considering the compressional-friction heating and radiational environment to which the thermistor is exposed, it was found that this sensor should give accurate information at heights below approximately 58 km (190,000 feet). Above this level, a correction factor should be applied. Because of the assumptions employed, not only in the derivation of the equations, but also in the specification of the thermistor environment, the correction factors lose their reliability above approximately 65 km. Also discussed are the evaluation of the ARCAS parachute fall speed and rocketsonde data analysis and interpretation. I.v.L.

N63-17750 Deutsche Bundespost. Ionospharen Inst., Breisach (W. Germany)
F_2 LAYER IONIZATION
K. Rawer Repr. from Advances in Upper Atmosphere Research (AGARD), 1963 p 159-207

Ionization in the F2 layer in the ionosphere is discussed. Included are possible sources of ionization, height variation of ion recombination, transport phenomena, diffusion, diurnal and seasonal variations, maximum electron density, height of maximum ionization, solar cycle influence, and the F2 layer height profile. C.L.W.

N63-17757 Army Cold Regions Research and Engineering Lab., Hanover, N.H.
Quarterly Progress Report, Feb.-Apr. 1963 [PHYSICAL AND MECHANICAL PROPERTIES OF SNOW, ICE, AND FROZEN GROUND AND THEIR INTERRELATIONSHIPS WITH METEOROLOGICAL PHENOMENA OF POLAR ENVIRONMENTS]
James A. Bender and R. W. Gerdel [1963] 5 p

The climatic and meteorological phenomena of polar environments are investigated so as to support and improve military capability in the cold regions. In the study of the physics of ice, snow, and frozen ground, travel times of ultrasonic pulses between piezoelectric transducers were remeasured, surveys of surface points were made to determine ice formations, and possible changes in the physical properties of polar ice were checked to find that recrystallization takes place at a depth of about two meters. The geophysics of polar structures included studies of the chemical composition of the ice core, X-ray diffraction studies of the soil, and electron probe analysis of the snow and frozen ground. The structural properties of the ice and snow were studied by ice tunnel deformation studies, and soil and ice chemical analyses. The environment of cold regions and atmospheric physics in polar regions was also studied. D.E.R.

N63-17909 Columbia U. Lamont Geological Observatory, Palisades, N.Y.
ANALOG ANALYSES OF SEISMOGRAMS RECORDED ON MAGNETIC TAPE
George H. Sutton and Paul W. Pomeroy Repr. from J. Geophys. Res., v. 68, no. 9, May 1, 1963 p 2791-2815 23 refs
(NASA Contract NASw-82; Contracts AF 19(604)-8485 and AF 19(604)-7376)
(NASA CR-50393; *Its* Contrib.-615)

Routine recording of long-period seismometer signals in analog form on magnetic tape makes it possible to perform a wide variety of analyses rapidly and efficiently. Examples of analog analyses of seismic waves from eight distant earthquakes, a large nuclear explosion, and the microseism storm associated with a hurricane illustrate some of the advantages of this type of recording. Results from the rotation of apparent instrumental coordinates to longitudinal horizontal, transverse horizontal, and vertical; multiplication of vertical and longitudinal components; and integration of this product serve as examples of the advantages of this type of data transformation. The analog magnetic tape seismograms can be digitized for any digital analyses desired, using a relatively simple, automatic, low-speed digitizer (two 3-decimal digit readings per second). Author

N63-17996 Sandia Corp., Albuquerque, N. Mex.
HUGONIOT DATA FOR SOME GEOLOGIC MATERIALS Research Report
R. C. Bass, H. L. Hawk, and A. J. Chabai June 1963 19 p 9 refs
(Supported by AEC)
(SC-4903(RR)) OTS: $0.50

Hugoniot data have been obtained for several geologic solids, including porous soils and porous and nonporous rocks. Effects of porosity and water content on Hugoniots of porous materials have been examined. Author

N63-18018 Air Force Cambridge Research Labs., Bedford, Mass.
ELECTRON DENSITY PROFILES OF WAVEMOTIONS IN THE IONOSPHERE CAUSED BY NUCLEAR DETONATIONS
George J. Gassmann Apr. 1963 25 p 14 refs
(AFCRL-63-440)

It is shown how an electron density cross-section in the vertical plane through an ionospheric wave can be constructed from a single station's ionospheric recordings, provided those are taken at time intervals not exceeding 5 minutes, and provided the general direction of travel is known. The described analysis yields also an approximate value for the velocity. Examples are presented of profiles of ionospheric waves from two different nuclear detonations, observed at great distances. A review of worldwide observations is given. Author

N63-18050 Minnesota U. Cosmic Ray Group, Minneapolis
ATMOSPHERIC PHENOMENA, ENERGETIC ELECTRONS, AND THE GEOMAGNETIC FIELD
J. R. Winckler July 1961 51 p 24 refs Presented in part at the URSI Symp. on Phys. Processes in the Earth's Plasma Environment, Wash., D.C., May 1, 1961
(NASA Contract NASw-56)
(NASA CR-50116; Tech. Rept. CR-40) OTS: $5.60 ph, $1.73 mf

This paper discusses X-ray measurements, associated with the dumping of electrons from the magnetic field, made aboard balloons and rockets. It is shown that in the normal auroral zone the X-ray bursts occur throughout the 24-hour period, have peak intensities corresponding to electron fluxes of 10^6 to $10^7/cm^2 \cdot sec$, and have integrated fluxes over a 24-hour period of $10^{10}/cm^2$. In the auroral zone, the X-ray bursts arising from 30-kv or higher electrons are not correlated with visible aurorae. Direct rocket measurements of bright aurorae in the auroral zone confirm this by showing the absence of appreciable electron fluxes above 20 kv. At lower latitudes, however, the X-rays are well-correlated with visible aurorae, have peak burst intensities of 10^9 electrons/$cm^2 \cdot sec$ greater than 30 kv, and are also strongly correlated with negative bays in the local magnetic field. The Van Allen outer-radiation-belt electrons provide a suitable reservoir for explaining many characteristics of the X-rays because of the latitude distribution and energy of the trapped radiation. Acceleration, deceleration, and redistribution processes are suggested which may result in the precipitation of these electrons to form the X-rays. Author

N63-18067 National Aeronautical Establishment (Canada)
SOME CHEMICAL ASPECTS OF UPPER ATMOSPHERE RESEARCH
L. Elias *In* National Research Council of Canada, Ottawa Quarterly Bull. of the Div. of Mech. Eng. and the Natl. Aeron. Estab., 1 Jan. to 31 Mar. 1963 p 8-40 62 refs

The chemical properties of the upper atmosphere, from 15 km to 200 km, are discussed. The direct investigation of the region by rocket-borne equipment is described; and some laboratory investigations, using chemiluminescent seeding agents of the composition of the upper atmosphere, are outlined. Research vehicles of the type of the Nike-Cajun rockets, the Aerobee rocket, and the Russian Meteorological rocket are described, and the instrumentation used, e.g., the telemetry systems, and the problems of such research are given. The nature of the upper atmosphere is discussed: (1) solar radiation; (2) temperature, density, and pressure; and the chemosphere-ozone, atomic nitrogen, oxides of nitrogen content, and the night sky luminescence. D.E.R.

N63-18125 Weapons Research Establishment (Australia)
IBM 7090 PROGRAMMES FOR SURVEYORS
D. C. Knight May 1962 38 p 6 refs
(WRE-TM-TRD-63)

Formulae and methods that are used in programing several conversions and computations frequently required in survey and trajectory work are given. Author

N63-18152 Army Map Service, Washington, D.C.
THE APPLICATION OF OCCULTATIONS TO GEODESY
S. W. Henriksen Dec. 1962 96 p 33 refs
(AMS-TR-46)

Equations which govern the use of occultations for geodetic surveying are presented. Also presented are error analyses of the following error sources: (1) star positions, (2) moon positions, (3) geodetic coordinates of the observer, and (4) timing of the occultation. I.v.L.

N63-18165 RAND Corp., Santa Monica, Calif.
A NOTE ON THE COMPRESSION OF THE EARTH'S MAGNETIC FIELD AND HYPOTHETICALLY RELATED PHENOMENA
Louis R. Henrich Repr. from J. Geophys. Res., v. 68, no. 5, Mar. 1, 1963 p 1295-1302 15 refs
(NASA Contract NASr-21(05))

The magnetic field of the earth is assumed compressed by an incident stream of ionized particles from the sun. A time-dependent magnetic and electric field is propagated as part of this interaction. A simplified model, a mirror dipole moving in space but of constant magnetic moment, is chosen to calculate the manner in which this electric field will compress, and possibly accelerate, ions already trapped in the earth's magnetosphere. This model would tend to dump radiation from the terrestrial belts into the atmosphere. For geometrical reasons, the effects might be most pronounced in early morning and late evening. Author

N63-18169 National Science Foundation. Office of Antarctic Programs, Washington, D.C.
USARP—UNITED STATES ANTARCTIC RESEARCH PROGRAM, NATIONAL SCIENCE FOUNDATION
May 1963 35 p
(NSF-63-14)

The United States Antarctic Research Program (USARP) is described and the procedure for submission of proposals is given. The research areas covered include biology, geology, crustal studies, glaciology, meteorology, upper atmosphere physics, and oceanography. The text of the Antarctic Treaty is included. R.C.M.

N63-18177 Southwest Center for Advanced Studies, Dallas, Tex.
DIURNAL VARIATION OF THE HYDROGEN CONCENTRATION IN THE EXOSPHERE
W. B. Hanson and T. N. L. Patterson May 22, 1963 45 p 19 refs Submitted for Publication
(NASA Grant NsG-269-62)
(NASA CR-50409) OTS: $4.60 ph, $1.55 mf

Three effects which must contribute to the diurnal variation of the abundance of atomic hydrogen in the exosphere of the earth are: (1) enhanced escape of hydrogen from the sunlit exosphere associated with the higher daytime temperatures; (2) lateral flow of hydrogen around the earth, resulting from a departure of the hydrogen abundance from spherical symmetry; and (3) flow of hydrogen into and out of the protonosphere by charge exchange with oxygen ions. Estimates are made of the importance of these effects. It is concluded that lateral flow of hydrogen is very efficient in preventing the formation of a large day-night asymmetry in the abundance of hydrogen. Author

13 HEAT TRANSFER

Includes: ablation; cooling; heating; and other thermal effects.

For aerothermodynamics see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 03 Aerodynamics of Wings and Control Surfaces.

For combustion see: 26 Propellants and Combustion.

For related information see: 11 Fluid Mechanics.

N63-17514 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

ON THE EMPIRICAL CORRELATION OF CRITICAL BOILING HEAT FLUX FOR CHANNELS OF VARIOUS CROSS SECTIONS AND ORIENTATION

Uwe H. von Glahn Washington, NASA, June 1963 22 p 9 refs
(NASA TN D-1656) OTS: $0.75

A correlation study is made of some of the experimental maximum heat-flux data (burnout condition) with net vapor generation. The data studied were obtained with water flow through circular tubes, rectangular channels, and annular tubes. Vertically upward, horizontal, and 45° inclined flow directions are considered. All channels were uniformly heated in the direction of flow. Correlation is achieved through modification of an existing empirical relation by the use of an additional channel-shape factor. The empirical relation itself consists of an enthalpy ratio and a function consisting of several dimensionless groups containing variables that include mass velocity, channel geometry, and fluid-property terms. All fluid-property terms are evaluated at the fluid saturation temperature associated with the burnout condition. Author

N63-17676 Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

AN EROSION GAUGE Research Note

L. E. Della Lucca, R. A. Skrivanek, and R. K. Soberman June 1962 12 p 4 refs
(AFCRL-62-640)

A system for measuring small variations in film thickness has been developed. The detector, although originally developed for measuring surface erosion on a space vehicle, can also be used for accurate laboratory measurements. The system uses a radioactive tracer technique, monitored by a scintillation counter connected to a pulse height analyzer. For space vehicle application, the use of a three-channel pulse height analyzer is particularly advantageous since it allows one to separate background radiation and electronic drift from the desired activity levels, while using only three dc level telemetry points. The first detectors to be flown will monitor the erosion of vacuum-evaporated silver films approximately 100A thick. An accuracy of 3 percent is expected from the flight detectors. Author

N63-17682 Callery Chemical Co., Pa.

DETERMINATION AND ANALYSIS OF THE POTENTIALITIES OF THERMAL ENERGY STORAGE MATERIALS [Final] Technical Report [July 1, 1961-Aug. 30, 1962]

K. W. Beahm and H. W. Wilson et al Wright-Patterson AFB, Ohio, Directorate of Aeromechanics, Jan. 1963 113 p 10 refs
(Contract AF 33(616)-7224)
(ASD-TR-61-187, Pt. II)

The results of a program to determine and analyze the potentialities of three candidate thermal-energy-storage materials are presented in this report. The program consisted basically of three major tasks: (1) a materials compatibility study; (2) an experimental program to determine the physical and thermodynamic properties of energy-storage materials; and (3) the design, construction, and operation of a unit to measure the heat release rates and movement of the fusion front in thermal-energy-storage materials utilizing latent heat of fusion. The results of these studies are discussed, the experimental data tabulated, and the apparatus used for the various measurements are described. Author

N63-17800 Marquardt Corp., Van Nuys, Calif.

SELECTING A THRUST CHAMBER COOLING TECHNIQUE FOR SPACECRAFT ROCKET ENGINES

Clifford D. Coulbert N.Y., AIAA [1963] 31 p 7 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17-20, 1963
(NASA Contract NAS7-103)
(AIAA Paper 63-241) AIAA: $0.50 members, $1.00 nonmembers

This paper presents the results of a number of chamber cooling design studies graphically over a wide range of parameters in a manner to permit the selection of the applicable thrust chamber cooling methods and evaluation of the factors leading to the selection of the most suitable design. Design factors such as the effect of duty cycle, throat area increase, throttling, gas stratification, space restarts, and space environment are evaluated. Author

N63-17861 Midwest Research Inst., Kansas City, Mo.

EXPERIMENTAL INVESTIGATIONS OF LIQUID METAL CONDENSATION

K. R. Mecklenburg [1963] 18 p 4 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session III-B, San Antonio, Tex., Apr. 16-19
(Contracts AF 33(616)-7336 and AF 33(616)-6854)

The experimental requirements of a program for determining the heat-transfer film conductance of condensing liquid metals are outlined and discussed. The program has been divided into three steps: (1) the fabrication and operation of a small boiler to determine the feasibility of certain design concepts; (2) the design, fabrication, and operation of a large boiler that will provide the required heat-transfer data; and (3) the fabrication and operation of a boiler constructed of materials capable of determining the heat-transfer properties of various liquid metals up to 2500° F. The small boiler used in Step 1 is described and experimental results obtained with this boiler are presented. Overall heat transfer coefficients determined at low heat flux levels are presented for sodium from 1151° to 1825° F and for rubidium from 962° to 1620° F. A larger boiler to be used in Step 2 is described, and plans for Step 3 are outlined. Author

N63-17869 Hughes Aircraft Co., Fullerton, Calif.

ADVANCED ELECTRONIC COOLANTS

C. W. Mell and L. J. Martin [1963] 20 p 6 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VI-B, San Antonio, Tex., Apr. 16-19

Single-phase fluid coolants have been studied for the temperature ranges −80° F to 400° F and −65° F to 650° F. Target requirements were established for electrical and physical properties. One hundred and fifty fluid samples were tested, first by screening tests, then by supplementary tests, and finally by circulation in a dynamic loop to simulate actual service conditions. Five fluids were found to meet the −80° F to 400° F requirements. One fluid passed the 650° F range screening tests and four others were marginal. A method of calculating a "Figure of Merit" is presented, and employed for evaluating the fluids. Author

N63-17899 Avco Corp. Research and Advanced Development Div., Wilmington, Mass.
MEASUREMENT OF HEAT TRANSFER ON A FLAT PLATE-STEP MODEL AT MACH 14
V. A. Sandborn and K. Heron June 26, 1963 38 p 8 refs
(Contract AF 04(694)-239)
(RAD-TM-63-40)

An experimental study of the separation of a hypersonic boundary layer ahead of a step on a flat plate is reported. The measurements were made in a Mach-14 shock tunnel. The flow field is visually observed with a glow probe. Local heat-transfer distribution along the flat plate and up the face of the step is reported. The detailed heat-transfer distribution shows a local increase in heat transfer associated with the separation shock, a decrease in heat transfer just downstream of the separation point, and a second increase in heat transfer as the step is approached. Directly at the corner between the flat plate and the step, the heat transfer reverses direction and is from the heat gage to the stream. No explanation was found for the corner effect. Preliminary measurements of the local heat-transfer distribution across the separation layer with hot-wire calorimeters are also reported. Author

N63-17925 Rutgers U., New Brunswick, N.J.
BASE HEATING ON A MULTIPLE PROPULSION NOZZLE MISSILE
R. J. Dixon (Boeing Co.) and R. H. Page N.Y., AIAA [1963] 10 p 5 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17-20, 1963
(AIAA Paper 63-179) AIAA: $0.50 members, $1.00 nonmembers

A theoretical model of the flow field at the base of a multi-nozzle missile has been developed. The model is used to calculate convective base-heat-transfer rates and pressures on the missile base. The theory is compared to test data, and is shown to be in good agreement. Some of the significant results obtained from a parametric investigation of a missile base are presented. Author

N63-18052 Cornell U. Agricultural Research Service, Ithaca, N.Y.
THE ENERGY BUDGET AT THE EARTH'S SURFACE. PART I
Edgar R. Lemon, Joseph H. Shinn, Conrad S. Yocum (U.S. Dept. of Agr.), and J. H. Stoller (Cornell U.) Washington, Dept. of Agr., May 1963 37 p 31 refs
(USAEPG Cross Service Order 3-59)
(Production Res. Rept. 71)

Energy-balance studies in a wintertime snowfield, under solar radiation intensities comparable to those in a summertime cornfield, reveal how important albedo (solar radiation reflection) is to the energy balance. In an investigation of the surface aerodynamic properties of a cornfield, it was found that the elastic properties of the surface cause the "roughness length" to increase with windspeed, and the "crop displacement" to decrease with windspeed. This suggests that with increasing windspeed the corn-crop surface appears to increase in roughness length, and thus act as a greater momentum sink. Theoretical estimates of the role played by photosynthesis in the energy balance reveal the possibility of much greater energy utilization in the photochemical fixation of carbon dioxide than was heretofore realized. Author

N63-18137 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LOCAL HEAT TRANSFER AND RECOVERY TEMPERATURES ON A YAWED CYLINDER AT A MACH NUMBER OF 4.15 AND HIGH REYNOLDS NUMBERS
Ivan E. Beckwith and James J. Gallagher Washington, GPO, 1961 26 p 26 refs
(NASA TR R-104; supersedes NASA MEMO 2-27-59L)
GPO: $0.40

Local heat transfer, equilibrium temperatures, and wall static pressures have been measured on a circular cylinder at yaw angles of 0°, 10°, 20°, 40°, and 60°. The Reynolds-number range of the tests was from 1×10^6 to 4×10^6 based on cylinder diameter. Increasing the yaw angle from 0° to 40° increased the stagnation-line heat-transfer coefficients by 100 to 180 percent. A further increase in yaw angle to 60° caused a 40-percent decrease in stagnation-line heat-transfer coefficients. At zero yaw angle, the boundary layer over the entire front half of the cylinder was laminar, but at yaw angles of 40° and 60° it was evidently completely turbulent, including the stagnation line, as determined by comparison of local heat-transfer coefficients with theoretical predictions. At all yaw angles, the peak heat-transfer coefficient occurred at the stagnation line and the chordwise distribution of heat-transfer coefficient decreased monotonically from this peak. The theoretical heat-transfer distributions for both laminar and turbulent boundary layers are calculated directly from simple quadrature formulas derived in the present report. Author

N63-18162 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
MEASUREMENT OF THE HEAT TRANSFER TO BODIES OF REVOLUTION IN FREE FLIGHT BY USE OF A CATCHER CALORIMETER
Gary T. Chapman and Charles T. Jackson, Jr. Washington, NASA, July 1963 39 p 8 refs
(NASA TN D-1890) OTS: $1.00

A new experimental technique has been used to study the total heat transfer to a hemisphere and a blunted cone. Aluminum models were gun-launched at speeds up to 11,000 fps, allowed to decelerate aerodynamically to a few hundred feet per second, and caught, and the total aerodynamic heat input was measured in the recovered models with a calorimeter. These measurements showed that for the trajectories flown, that portion of the initial kinetic energy which goes into heating the body was larger for the configuration with the smaller drag. The data were further analyzed on the basis of the trajectories traversed, yielding heat-transfer rates as a function of velocity. These rates for the various configurations were compared with one another, and again showed that the configuration with the higher drag had the lower heating rates. Further, the experimental heating rates for the hemisphere agreed well with the theoretical convective heating of the front face. Author

N63-18174 Smithsonian Astrophysical Observatory, Cambridge, Mass.
A CRITERION FOR THE MODE OF ABLATION IN STONE METEORS
Allan F. Cook Washington, Smithsonian Inst., 1963 9 p 3 refs
(*Its* Contrib. to Astrophys., v. 4, no. 5) GPO: $0.15

Evidence is presented that Meteor 19816, of the program of the Harvard Meteor Expedition, passed from ablation by melting and spraying to ablation by vaporization, and back to ablation by melting during its luminous flight through the atmosphere. A criterion is proposed for the mode of ablation. If ablation by vaporization is assumed, it is possible to compute the ratio of the heat transports parallel and normal to the surface of the liquid layer just beneath that surface. A critical value of this ratio of approximately one is found from the meteor. Author

N63-18193 Defense Metals Information Center, Battelle Memorial Inst., Columbus, Ohio
NOTES ON LARGE-SIZE FURNACES FOR HEAT TREATING METAL ASSEMBLIES
H. J. Hucek, A. R. Elsea, and A. M. Hall May 24, 1963 14 p 4 refs
(DMIC-MEMO-167; supersedes DMIC-MEMO-63)

The availability and location of extra-large-capacity furnaces for the heat treatment of the high-strength steels used in the manufacture of high-speed aircraft and missiles is summarized. Most of the companies listed as having furnaces also have metallurgical test facilities available which include Magnaflux, X-ray, tensile, and hardness testing. Many have additional facilities such as Magnaglo, ultrasonic inspection, spectrograph, chemical analysis, and metallographic laboratories. Most of these furnaces are bottom-open gantry furnaces using an endothermic protective atmosphere. I.v.L.

14 HUMAN BEHAVIOR

Includes: crew training and evaluation; piloting; psychological factors.

For simulators see: 10 Facilities.

For related information see: 16 Life Sciences.

N63-17584 Florida State U., Tallahassee
EFFECTS OF STIMULUS SIMILARITY AND DELAY ON TRANSFER OF TRAINING [Final Report, 1 June 1959-30 Apr. 1961]
Joel Greenspoon and John E. Anderson, Jr. Wright-Patterson AFB, Ohio, Behavioral Sci. Lab., Apr. 1963 36 p 26 refs
(Contract AF 33(616)-6408)
(AMRL-TDR-63-26) OTS: $1.25

This research was concerned with the effects of stimulus similarity and delay on transfer to a visual-motor task. Subjects were trained on the same stimulus value, and then retrained on the same or different stimulus values after varying intervals of time. The results indicated that both variables significantly affected the amount of positive transfer, although the results were not unequivocal. The greatest amount of transfer occurred on stimulus values that were closest to the stimulus value of original training. Moreover, the longer time intervals between original learning and test of transfer tended to produce the greater amount of transfer. The transfer effect tended to be short-lived in that subjects who had no prior experience with the task were performing as well as the subjects with prior experience after a relatively small number of trials. Author

N63-17585 Ohio State U. Lab. of Aviation Psychology, Columbus
THE EFFECT OF REHEARSAL ON THE RETENTION OF A TIME-SHARED TASK [Final Report, May 1, 1960-July 1, 1962]
James C. Naylor, George E. Briggs, Donald R. Brown, and Walter G. Reed Wright-Patterson AFB, Ohio, Behavioral Sci. Lab., Apr. 1963 28 p 17 refs
(Contract AF 33(616)-7269)
(AMRL-TDR-63-33) OTS: $0.75

Two studies were performed to investigate the influence of various methods of task rehearsal upon the retention of a time-shared task. Experiment I examined retention as a function of four rehearsal conditions (part task, whole task, simplified task, and none). Subjects in each of the groups trained for 8 days, returned 6 days later for 2 days of rehearsal, and then returned again after 7 more days for a retention test. Experiment II examined retention both as a function of 3 rehearsal methods (whole, part, and none) and amount of training (5 or 10 days). Subjects returned for 2 days of rehearsal 10 days after completion of training and then returned for rehearsal methods. In Experiment I, part rehearsal was superior, whereas in Experiment II whole rehearsal was found to be best. Author

N63-17634 Electronic Systems Div. Operational Applications Lab., Bedford, Mass.
ACQUISITION OF A PROBABILISTIC DISCRIMINATION BETWEEN SUBSEQUENT ALTERNATIVE EVENTS
Donald B. Cameron Mar. 1963 22 p 4 refs
(ESD-TDR-63-134)

Acquisition of stable predictive decisions and consistent discrimination between pairs of alternative stimuli is shown to be dependent upon both the frequency of occurrence of each member of a pair and the degree of similarity between such members. The rate of acquisition is determined by the degree of similarity with highly similar alternatives requiring the greater length of time before stable predictive decisions occur. The terminal asymptotic rate of such predictive decisions is determined by the actual frequency of occurrence of alternative members of the discriminated set. Author

N63-17762 Massachusetts U. Inst. of Environmental Psychophysiology, Amherst
EFFECTS OF DIFFERENTIAL VALUE AND EXPOSURE TIME UPON THE DETECTION AND MEMORY SYMBOLS IN A VISUAL SEARCH TASK
Harvey A. Taub and Warren H. Teichner Bedford, Mass., Decision Sci. Lab., June 1963 55 p 16 refs
(Contract AF 19(621)-290)
(ESD-TDR-63-343)

The accuracy of reporting data from briefly-exposed, multitarget symbolic displays, in which the value or importance of the targets varies within the display, was shown to vary inversely with the differential ratio of value of the targets. The data also suggested that (1) an increase in differential ratio does not facilitate the reporting of more important targets, but rather decreases reports of less important ones, (2) the difference in accuracy of report to high- and low-valued targets varies directly with exposure time up to 2.5 sec for the display used, with 1.5 sec as a possible optimum. The results are consistent with the hypothesis that differential value produces a selective recall from short-term memory storage. Author

N63-17926 National Aeronautics and Space Administration, Washington, D.C.
MANNED SPACE FLIGHT TEAM
[1963] 13 p
(NASA EP-11) GPO: $0.15

A brief biographical sketch for each of the 16 astronauts on the U.S. manned spaceflight team is presented and some statistical averages for the team are given, such as: height—5 feet 10 inches; weight—160 1/2 pounds; age—35 years; and flighttime logged—1,200 hours in conventional aircraft and 1,800 hours in jet aircraft. D.E.R.

N63-17952 Applied Psychology Corp., Arlington, Va.
FLIGHT SIMULATOR TESTS OF ALTITUDE-CODED LIGHTS
Technical Report No. 8
Mar. 1962 35 p 4 refs
(Contract FAA/BRD-127)

A regularly flashing, fixed-frequency light and a light giving altitude information by means of dot-dash signals were compared in terms of their usefulness to pilots who were trying to judge the relative altitude and vertical flight path of a simulated intruder aircraft. Standardized problems were constructed for a modified F-100/151 flight simulator, and included three rates of altitude change, approaches from left and right, and a number of collisions and misses. Accuracy in determining both relative altitude and vertical flight path of the intruder was better with the altitude-coded light than with the regularly-flashing, fixed-frequency light. With both kinds of lights, pilots became less accurate in judging relative altitude, but more accurate in judging vertical flight path, as the rate of altitude change increased. Author

N63-17954 Allied Research Associates, Inc., Boston, Mass.
A NEW APPROACH TO SPACE EXPLORATION
John Merchant Repr. from Aeron. and Aerospace Eng. [1962]
(NASA Contract NASr-16)
(NASA CR-50221)

A Remote Interaction System, to augment manned space travel, is proposed. It would comprise efficient remote extensions of man's important sensory and motor functions. The range of a fully effective system would probably be limited by transmission delays to about 10,000 miles. This would be sufficient to allow remote interaction from earth to earth orbit, or from a spacecraft in lunar orbit to the lunar surface, or from planetary orbit to a planet surface. Author

15 INSTRUMENTATION

Includes: design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gauges; and sensors and transducers.

For related information see: 06 Auxiliary Systems; 08 Communications; 09 Electronics; and 22 Navigation and Guidance.

N63-17528 Little (Arthur D.), Inc., Cambridge, Mass.
NEAR INFRARED BACKGROUND CLUTTER AND ATMOSPHERIC TRANSMISSION. INSTRUMENTATION Semiannual Report [Nov. 1962-May 1963]
E. C. Reifenstein, III, P. C. v. Thuna, and H. H. Blau, Jr. May 1963 12 p
(Contract AF 04(695)-202)
(SSD-TDR-63-146)

The instrumentation phase of an infrared background measurement program, whose objective is to obtain infrared background data from a U-2 aircraft that will assist in the design and evaluation of future space-based infrared detection systems, is summarized. Specifically, it is planned to measure the statistics of background clutter in the 1 to 3 micron region with 0.10 micron resolution for a variety of geometrical conditions of solar illumination and viewing and to measure solar spectra for a range of aircraft altitudes and solar elevations. N.E.A.

N63-17591 Naval Research Lab., Washington, D.C.
THERMOLUMINESCENT DOSIMETERS ON RECOVERABLE SATELLITES
W. E. Price (Lockheed Missiles and Space Co.), F. H. Attix, and E. J. West May 28, 1963 12 p 15 refs
(NRL-5938)

A miniature dosimeter, 1 mm diam and 13 mm long, for ionizing radiation, based upon thermoluminescence in CaF_2:Mn has recently been developed at NRL. Groups of these dosimeters have been flown on six recoverable satellites, from which four payload capsules have been successfully retrieved and the dosimeters returned for readout. The polar orbits had apogees ranging from 306 to 578 km, and the satellites made 18 to 65 revolutions before recovery. The resulting absorbed doses for dosimeters shielded by 1.7g/cm^2 of low-atomic-number material ranged from 1.8 to 4.5 millirad per orbit, based upon Co^{60} γ-ray calibrations. Dosimeters enclosed in an added 14 g/cm^2 Pb read about 43 percent less, in rough agreement with calculation based upon a trapped-proton spectrum. The observed readings are not inconsistent with the assumption that most of the proton flux was encountered in a region over the South Atlantic. Author

N63-17618 Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho
THE DESIGN OF A POTENTIOSTAT FOR ELECTROCHEMICAL RESEARCH
R. H. Brown AEC National Reactor Testing Station, May 1963 40 p 8 refs
(Contract AT(10-1)-205)
(IDO-16852) OTS: $1.00

Improved ways to recover U^{235} from spent nuclear reactor fuel elements are sought. The fuel element must first be dissolved to recover the U^{235}. One method of studying the electrochemical parameters involved in the electrolytic methods of dissolution is to observe the electrical behavior of one electrode with respect to a reference electrode in a cell which has been filled with electrolyte. An equivalent circuit is used to demonstrate the relationship of the parameters of the electrolytic cell. A description of the development of a potentiostat to study the η-i_c relationship of the cell under constant E_i conditions is given. Performance and auxiliary requirements of the potentiostat for successful operation are discussed. The potentiostat met or exceeded these requirements with the exception of the static requirement. The potentiostat was successfully operated for a number of weeks; a negative slope E_i vs. i_c curve was obtained. N.E.A.

N63-17640 Lockheed Missiles and Space Co., Sunnyvale, Calif.
RADIATION DISCRIMINATORS: AN ANNOTATED BIBLIOGRAPHY
Charlie M. Pierce, comp. Oct. 1962 27 p 57 refs
(SB-62-34; Rept. 3-80-62-23)

The scope of this search involves instrumentation and circuitry which have been designed to discriminate between the various types of nuclear radiations. A majority of the selected references describe techniques for measuring the intensity of a particular type of radiation,in a mixed radiation field. Author

N63-17700 Airlines Communications Administrative Council. Airlines Electronic Engineering Committee, Washington, D.C.
ALTITUDE COMPUTER SYSTEM. ARINC CHARACTERISTIC NO. 549
Washington, D.C., Aeronautical Radio, Inc., Mar. 1, 1962 85 p 27 refs

Standards and characteristics of an altitude computer system for use by commercial airlines are presented. This equipment will accept inputs of static pressure and, in some cases, Pitot pressure or Delta-H in electrical form so as to make appropriate computations of pressure altitude which will be useable externally in two forms: (1) a digitized output in 100-ft increments for feeding an ATC transponder or a combination of an altitude encoder used with an ATC transponder; and/or (2) pressure altitude information to a pilot's display or to other accessories by means of a two-speed synchro output suitable for driving an altimeter repeater indicator. Three models of the altitude computer system (Mark 1, Mark 2, and Mark 3) are included in this characteristics report. Although different form factors and connectors are employed in each, all of the models will utilize the same interwiring and standardized inputs and outputs. M.P.G.

N63-17718 American Electronic Labs., Colmar, Pa.
RF PREAMPLIFIER AND CONVERTER FOR TEST AND EVALUATION Final Engineering Report
Mar. 20, 1963 23 p
(Contract FAA-ARDS-609)

The AEL RF Preamplifier and Converter, ARDS Type 111-24D, is an adapter unit to be used in conjunction with presently used VHF receivers. The unit is fixed tuned, and operates from 108 to 152 mc/s. It will enable the VHF receiver to be used on channels requiring 50 kc/s channel separation. The AEL RF Preamplifier and Converter has a highly selective RF front end which yields very low cross-modulation and high selectivity. The unit is powered from 115 volts a.c., 60 cycles. Author

N63-17720 Kiruna Geophysical Observatory (Sweden)
A SYSTEM FOR AUTOMATIC COLLECTION AND PROCESSING OF STANDARD MAGNETOMETER DATA, AND THE CALCULATION OF THEIR POWER SPECTRUM Annual Summary Report, Oct. 1, 1961–Nov. 30, 1962
G. Gustafsson, A. Thunberg, and K.-E. Heikkilä Apr. 10, 1963 32 p 3 refs
(Contract AF 61(052)-237)
(AFCRL-63-635)

The equipment which was constructed for collection of geomagnetic data will sample all three components of the earth's magnetic field each 30 seconds. It has been tested for recording of one component, and found to be working satisfactorily. A computer program has been developed for the reduction of the data. An analysis has also been made of the spectrum of the fluctuations of the geomagnetic X-component in the frequency range 0.5 to $4.2 \cdot 10^{-4}$ cps. Author

N63-17736 General Electric Co., Cincinnati, Ohio
REACTOR INSTRUMENTATION AND CONTROL Progress Report [Mar. 1–May 1, 1963]
May 31, 1963 41 p 9 refs
(Contract AT(40-1)-2847)
(GEMP-77)

Progress is reported on reactor instrumentation and control research in the following areas: (1) circulating-ball reactivity control; (2) static switching; (3) capacitance temperature sensor; (4) high-temperature extension of conventional nuclear sensors; and (5) development of nuclear sensors. N.E.A.

N63-17749 Airlines Communications Administrative Council. Airlines Electronic Engineering Committee, Washington, D.C.
ALTITUDE ENCODER. ARINC CHARACTERISTIC NO. 548
Mar. 1, 1962 19 p 26 refs

Requirements are set forth for an accessory unit, an altitude encoder, designed for operation with an ARINC model 532C ATC transponder. The altitude encoder accepts a digitized altitude encoded signal input and coverts this into a pulse train suitable for triggering the transponder whenever it is interrogated on mode C. This altitude encoder unit is to use d.c. current only, of 27.5 volts nominal, +10%, −20%, and with a maximum total current requirement of not more than 3 amps, such that it may be protected by a 5-amp circuit breaker in the main distribution panel of the aircraft. C.L.W.

N63-17771 Oak Ridge National Lab., Tenn.
TESTS OF HIGH-EFFICIENCY FILTERS AND FILTER INSTALLATIONS AT ORNL
E. C. Parrish and R. W. Schneider June 3, 1963 46 p 8 refs
(Contract W-7405-eng-26)
(ORNL-3442) OTS: $1.25

High-efficiency filters are used in air-handling systems as the primary means of minimizing the amount of radioactive particulate matter released to the atmosphere. The feasibility of measuring the filtration efficiency of "systems" containing such filters has been established at ORNL. Since the middle of 1962, the efficiency of more than 650 systems has been successfully measured *in situ*, using an aerosol of dioctylphthalate and a forward light-scattering photometer. In addition, over 1500 new filters have been checked prior to being placed in ORNL stores' stock. Tests have been made to determine (1) the linearity of the Naval Research Laboratory type photometer, (2) the precision of filter efficiency determinations, (3) the effect of prolonged exposure to aerosol on filtration efficiency, and (4) the effect of airflow rate on the efficiency of both efficient and defective filters. Author

N63-17902 Aerospace Information Div., Library of Congress, Washington, D.C.
FILM THICKNESS CONTROL BY MEANS OF A CRYSTAL RESONATOR
A. I. Akishin and V. S. Zazulin June 19, 1963 7 p 4 refs Transl. from (Kontrol' tolshchiny plenok, poluchayemykh v vakuume, kvartsevym rezonatorom) Pribory i tekh. esperimenta, no. 1, 1963 p 152–154
(AID-T-63-86) OTS: $1.10 ph, $0.80 mf

This article describes a method of continuous control, by means of a quartz resonator, of the thickness of thin metallic films prepared in a vacuum by evaporation, or any other means. The maximum sensitivity of the method is $\sim 10^{-9}$ g/cm^2. Calibration data are given for a 16-mc quartz crystal. The method may also be applied to the study of cathode and certain surface phenomena. Author

N63-17917 Weapons Research Establishment (Australia)
THE DEVELOPMENT OF FABRICATION, EJECTION AND INFLATION TECHNIQUES FOR SPHERES OF VARYING AREA/MASS RATIO
T. H. Cooke Oct. 1962 33 p 11 refs
(Tech. Note SAD-98)

The use of reflective spheres of varying cross-sectional area/mass ratio is proposed for use in falling sphere density determination in the 40- to 100-km region of the atmosphere. This note outlines the development of fabrication, ejection, and inflation techniques, and explores the probable limit of cross-sectional area/mass ratio using a weighted skin. Author

N63-17928 Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.
SUPERPRESSURE BALLOON FOR CONSTANT LEVEL FLIGHT
L. A. Grass Aug. 1962 73 p 14 refs
(AFCRL 62-824; *Its* Instrumentation for Geophys. and Astrophys. No. 21)

Superpressure balloons are highly stable platforms for long-duration experiments in the stratosphere, capable of remaining at constant-density altitude, without ballast, despite diurnal fluctuations in "superheat" of the lifting gas. Duration is theoretically limited only by eventual deterioration of the plastic or loss of gas by permeation. Equations relating superpressure, superheat, and free lift are derived. Developmental problems, design, cold-chamber testing, and relative merits of cylinder, tetrahedron, onion, and sphere are discussed. Flight data confirm capability of laminated-Mylar spheres with preformed end caps and bitape seals. Author

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N63-17944 Grumman Aircraft Engineering Corp., Bethpage, N.Y.

EVALUATION OF GAS COMPOSITION DETECTION METHODS IN MANNED SPACE VEHICLES [Interim Report]

Arnold Reed Dec. 1962 29 p
(ADR-04-06-62.1)

The polarographic cell and the electrochemical cell are the best of the available methods for sensing the partial pressures of oxygen and carbon dioxide, respectively. The "time of flight" mass spectrometer and the gas chromatograph are the two prime approaches to the problem of toxic and noxic gas monitoring. Both of these approaches are in the development stages. The first "flight hardware" gas chromatograph was delivered to NASA in November 1962. Author

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N63-17958 Rochester U. Inst. of Optics, N.Y.

COMMON PATH INTERFEROMETER USING FRESNEL ZONE PLATES

M. V. R. K. Murty Repr. from J. Opt. Soc. Am., v. 53, no. 5, May, 1963 p 568–570 Presented at the 47th annual meeting of the Opt. Soc. of Am., Rochester, N.Y., Oct. 1962
(NASA Contract NASr-14)
(NASA CR-50413)

A new kind of interferometer for testing any unit magnification optical system is described. The method utilizes diffraction beam splitting, and involves the use of two identical Fresnel zone plates, one by the side of the other. The interference patterns obtained are easy to interpret because the fringes are the loci of equal optical path difference of the wavefront under test with respect to a reference sphere. Author

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N63-18076 Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

MEASUREMENT RANGE REQUIRED OF METEOROLOGICAL EQUIPMENT Research Note

Arnold Court and Henry Salmela Aug. 1962 14 p
(*Its* Instrumentation for Geophys. and Astrophys. 22; AFCRL-62-825)

This report develops the "improbable extreme" conditions which surface instruments must be designed to measure: temperatures from −140° F to +160° F, dewpoint at any temperature, T in deg F, given by T/2-80, rainfall during t minutes $2\sqrt{t}$ inches, wind speeds up to 250 mph, and pressure from 506 to 1062 mb. Atmospheric sounding systems must be able to measure temperatures and corresponding dewpoints over the same range, winds up to 300 mph below 100,000 ft, and pressures whose ratio to the Standard Atmosphere pressure, p, at the maximum height they are expected to attain, is $0.1\ (6 + \log p)$ up to 133 km, and 0.1 at still higher levels. Author

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N63-18111 Ohio State U. Research Foundation. Antenna Lab., Columbus

A LIQUID CALORIMETER FOR LASER ENERGY

James T. Flynn (M.S. Thesis) Nov. 15, 1962 57 p 10 refs
(Contract AF 33(616)-7081)
(Rept. 1083-18)

A liquid absorption calorimeter for laser energy has been designed and tested. Its primary advantage over carbon or metal calorimeters is the absorption of the incident energy throughout a volume rather than on a surface, thus limiting the initial temperature rise to a few degrees. Two models have been built, and tested with pulsed ruby lasers; both use thermistor-bridge temperature sensors. No compensation of the bridge for ambient temperature variation is attempted, but final calibration curves include this variation. Measurements with accuracy of 10% are possible up to pulse energies of 10 joules, with a 40- to 60-second interval between measurements. The upper energy limit can be increased to any desired value by increasing the volume of the absorption cell, at the cost of a longer recovery time. Measurements of laser output versus pumping energy, and of laser output versus transmissivity of silver and gold end-films are shown. Author

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N63-18117 Aro, Inc., Arnold Air Force Station, Tenn.

CALIBRATION OF FOUR CONICALLY TIPPED FLOW SURVEY RAKES AT TRANSONIC SPEEDS

J. A. Black, W. E. Carleton, and C. F. Anderson Arnold Engineering Development Center, July 1963 37 p 3 refs
(Contract AF 40(600)-1000)
(AEDC-TDR-63-134)

Four flow survey rakes with one, two, four, and eight, 40-deg conically tipped probes were calibrated in the Transonic Model Tunnel of the Propulsion Wind Tunnel Facility, to establish pressure coefficient characteristics at selected Mach numbers and angles-of-attack, and to determine whether intraprobe interference existed at transonic speeds. The calibration was conducted at Mach numbers from 0.70 to 1.40, and angles-of-attack from −10 to +15 deg. The Reynolds number, based on cone maximum diameter, varied from 0.14 to 0.17 million. The results showed that pressure differences measured by diametrically opposed orifices were linear with angle-of-attack for all rake configurations. Total pressures and average static pressures measured on the probes decreased with increasing angle-of-attack. The two- and four-probe configurations showed no interference effects, and the eight-probe configuration indicated interference effects at all test Mach numbers. Author

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N63-18127 Los Alamos Scientific Lab., N. Mex.

HOWARD EBERLINE NEUTRON SURVEY INSTRUMENT PNC-1; EVALUATION AND RECOMMENDATION FOR USE

E. R. Graves May 22, 1963 33 p 11 refs
(Contract W-7405-eng-36)
(LA-2860) OTS: $0.75

A Howard Eberline Neutron Survey Instrument, PNC-1, has been evaluated for use as a neutron survey instrument. The sensitivity as a function of neutron energy has been measured for neutron energies varying from 10 Kev to 14 Mev. The calibration measurements are described. The application of the instrument to neutron monitoring is discussed, and a recommendation for convenient usage leading to rem per hour dose rates is given. Author

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N63-18189 Controls for Radiation, Inc., Cambridge, Mass.

ANALYSIS OF PULSED X-RADIATION GENERATED BY HIGH POWERED ELECTRONIC EQUIPMENT Final Report

James A. Wall June 18, 1963 132 p 13 refs
(Contract AF 30(602)-2493)
(RADC-TDR-63-29)

A scintillation spectrometer was tested for its ability to measure the spectra of pulsed X-radiation. It was found to be a useful instrument for the measurement of the spatial energy distribution of X-rays generated by high-powered electronic equipment. A theoretical study was conducted in an attempt to obtain a means of predicting the spatial energy distribution of X-rays generated by electrons with energies between 10 kv and 500 kv incident on a thick copper target. At least qualitative agreement was obtained between the theoretical and experimental results for X-rays generated by electrons with energies up to 74.7 kv. Different X-ray detectors were tested for their response to pulsed X-rays and RF radiation. Author

16 LIFE SCIENCES

Includes: biology; exobiology; physiology; medicine; life support systems; radiation effects on biological systems; and space sickness.

For related information see: 14 Human Behavior; and 28 Space Radiation.

N63-17483 Sylvania Electric Products, Inc. Applied Research Lab., Waltham, Mass.
AN EXPLANATION OF VISUAL ADAPTATION IN ACCORDANCE WITH THE SPECTRAL SCANNING THEORY
George Biernson May 1963 38 p 18 refs
(NASA Contract NASw-441)
(NASA CR-50351; Res. Note-395) OTS: $3.60 ph, $1.34 mf

The spectral scanning theory of color vision is extended to include visual adaptation. The spectral scanning theory postulates that the infinite dimensional light spectrum is converted by the waveguide mode effect to form a spectral pattern, which is then processed in the performance of visual adaptation. The processed spectral-pattern information is demodulated to generate the three-dimensional color signals. Because of the limited waveguide mode effect, the spectral pattern is not infinite dimensional, but it has a dimensionality higher than three. Multidimensionality in the spectral pattern would assure that very small variations in spectra would produce detectable differences in spectral patterns for wide ranges of illuminant spectra and object reflectance spectra. This would allow the eye to detect with high accuracy very small amounts of chromaticity in the reflectiority spectrum of an object, and very small differences in the reflectivity spectra of two neighboring objects. C.L.W.

N63-17491 Ionics, Inc., Cambridge, Mass.
THE RECOVERY OF WATER FROM URINE BY MEMBRANE ELECTRODIALYSIS [Final Report, Dec. 1961-Nov. 1962]
Daniel L. Brown, Robert W. Lindstrom, and J. Douglas Smith Wright-Patterson AFB, Ohio, Biomedical Lab., Apr. 1963 56 p 10 refs
(Contract AF 33(657)-7710)
(AMRL-TDR-63-30) OTS: $1.50

A laboratory-scale experimental program was conducted which clearly indicated the feasibility of membrane electrodialysis for recovering potable water from urine. Since electrodialysis removes electrolytes from urine, pretreatment techniques were investigated for the removal of nonelectrolytes. These techniques were: charcoal adsorption, chemical oxidation, and enzymatic hydrolysis of urea to ammonium carbonate. A model of a urine reclamation system was built, comprised of two main processes: charcoal adsorption and electrodialysis. The system weighs 15 pounds, is less than one ft^3 in size, and has a peak power requirement of 45 watts for 8 hours' operation for the daily recovery of 3000 ml of potable water from urine. The daily energy requirement is 310 watt-hrs, including 160 watt-hrs for charcoal regeneration. Excellent quality water is recovered in yields of 92%. The model has good reliability and can be readily adapted for conditions of weightlessness. Author

N63-17492 Spacelabs, Inc., Van Nuys, Calif.
METHOD OF PRESERVING FROZEN FOOD DURING AN AEROSPACE MISSION [Final Report, Feb. 1962-Nov. 1962]
Robert R. Reddy and Eugene B. Zwick Wright-Patterson AFB, Ohio, Biomedical Lab., Apr. 1963 36 p 3 refs
(Contract AF 33(657)-8019)
(AMRL-TDR-63-31; SR-62-1047) OTS: $1.00

Analyses of three nonelectrical methods for maintaining frozen foods between −10° F and +5° F during aerospace missions of 1 to 28 days are presented. The methods considered are: (1) a heat sink, (2) active refrigeration, and (3) radiation cooling. All methods appear feasible. The heat-sink method appears to be the simplest and most reliable. A design study of a heat-sink system for a 3-man, 14-day mission is included. Author

N63-17508 Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
THE OVERPRESSURE-DURATION RELATIONSHIP AND LETHALITY IN SMALL ANIMALS Technical Progress Report
D. R. Richmond, V. C. Goldizen, V. R. Clare, and C. S. White Washington, Defense Atomic Support Agency, Sept. 10, 1962 40 p 13 refs
(Contract DA-49-146-XZ-055)
(DASA-1325)

A total of 993 mice, rats, guinea pigs and rabbits were exposed to sharp-rising overpressures of various short durations. They were mounted on a concrete pad above which high-explosive charges, ranging in weight from 0.50 oz to 64 lbs, were detonated. Pressure-time measurements were obtained with pencil-type and shock-tube piezoelectric gages on the pad directly beneath the charges. The duration of the blast waves ranged from 0.40 msec to 6.8 msec. The LD_{50} pressures were calculated for each species at the different pulse durations. In general, the pressures required to produce 50-percent lethality rose at the shorter durations. Combining the results of this study with those from previous shock-tube investigations made it possible to define the tolerance of four small-animal species to sharply rising overpressures as a function of pulse duration. Author

N63-17555 Aerospace Medical Div. School of Aerospace Medicine, Brooks AFB, Tex.
STUDIES WITH A SIMULATED MARTIAN ENVIRONMENT. BACTERIAL SYNERGISM: PRELIMINARY SYSTEMS
Thomas L. Roberts, Robert J. Ball, Jr., and E. Staten Wynne Jan. 1963 8 p 6 refs
(SAM-TDR-62-151)

Simulated Martian environment permitted survival of endospores of *Bacillus cereus* but not the photosynthetic nitrogen-fixing soil bacterium, *Rhodospirillum rubrum*. There was no evidence of a synergistic relationship. Observed increases in colony counts of *B. cereus* appeared due to temperature cycling. Author

N63-17583 General Electric Co. Valley Forge Space Technology Center, King of Prussia, Pa.
RESEARCH OF ELECTROLYSIS CELL-FUEL CELL METHOD OF RECOVERING POTABLE WATER FROM URINE [Final Report, Mar. 1962-Feb. 1963]
Fred P. Rudek and Norman Belasco Apr. 1963 92 p 17 refs
(Contract AF 33(657)-7667)
(AMRL-TDR-63-32) OTS: $2.25

A program of study and applied research was conducted to determine the feasibility of combining an ion exchange membrane electrolysis cell and an ion exchange membrane fuel cell, so that oxygen and hydrogen which are electrolyzed from human urine recombine in the fuel cell to yield potable water and power. The latter, in turn, will satisfy some of the power requirements of the electrolysis cell. The experimental laboratory systems were synthesized from latest ion-exchange membrane technology, and produced water that is both chemically and bacteriologically well within limits of the "1961 U.S. Public Health Standards for Drinking Water." The system has high yield (98% of available water content), long operating life (37 days plus), and produces usable low-voltage electrical power. The electrolysis cell output also provides for a high-purity (to 99.5%) emergency oxygen capability. The design is basically a zero-G type, inherently providing separation of vapor and liquid. Trade-off evaluations indicate that the ELF System is competitive with other water-recovery systems presently being developed for space applications. Author

N63-17594 Agricultural Research Service. Soil and Water Conservation Research Div., Watkinsville, Ga.

RESEARCH IN PLANT TRANSPIRATION: 1961 [Annual Report, 1 July 1960 through 30 June 1961]

James E. Pallas, Jr., Donald G. Harris, Charles B. Elkins, Jr., and Anson R. Bertrand May 1963 41 p 279 refs
(Production Res. Rept. 70)

Experiments relating radiant energy, soil moisture tension, temperature, and humidity to transpiration are described and discussed. Prediction equations for a species relating plant transpiration to its environment are included. Experimentation on guard cell action and reaction is reported, including studies on the degradation and accumulation of starch in albino and normal plants, osmotic pressure fluctuations of guard cells, and amylase experiments attempting to artificially open stomata. Reactions to foliar sprays with certain growth regulators tested as transpiration suppressants are described. Author

N63-17607 Badger (W. L.) Associates, Inc., Ann Arbor, Mich.

STUDY OF PROCESSES FOR THE PRODUCTION OF POTABLE WATER FROM AQUEOUS WASTES DEVELOPED IN A SHELTER

Oct. 1962 120 p 91 refs
(Contract OCD-OS-62-120)

An adequate supply of potable water is an essential requirement in a fallout shelter. This study has evaluated many known means of converting aqueous shelter wastes into potable water. A comparison of various processes led to the selection of the three most feasible systems with a system of pre- and post-treatment and testing common to all. The processes selected as most likely to produce acceptable potable water are: (1) vapor compression distillation, (2) ion exchange and charcoal adsorption, and (3) electrodialysis. Preliminary specifications of equipment, utilities consumed, and estimated costs are given for each process. Water from the air, extracted by an air-conditioning system, is discussed and recommendations made. Recovery systems are contrasted to the normal means of water supply and it is recommended that the conventional means of supply should ordinarily be used. Recommendations are made for future research and development work. A bibliography covering the literature studied, charts, and process flow diagrams are included. Author

N63-17613 Naval Radiological Defense Lab., San Francisco, Calif.

REDUCED INCIDENCE OF PERSISTENT CHROMOSOME ABERRATIONS IN MICE IRRADIATED AT LOW DOSE-RATE

P. C. Nowell (Penn. U.) and L. J. Cole May 6, 1963 15 p 11 refs
(USNRDL-TR-644)

A marked difference in the production of persistent chromosome aberrations in mouse marrow cells by ionizing radiation, delivered at a high dose rate (30 rad/min) versus a low dose rate (1.45 rad/hour), was observed. Clones of cell with chromosome abnormalities were present in the marrow of all the mice previously exposed to the X-rays, either a single dose or fractionated, at 30 rad/min. The frequency of chromosome aberrations in these mice varied from 14% to 72% of the cells examined. By contrast, none of the 17 mice exposed to the continuous low dose-rate gamma radiation (1.45 rad/hour) showed definite clones of abnormal marrow cells, and the frequency of persistent chromosome aberrations varied from zero to 8% in this group. The possible basis for this marked reduction in the production of persistent chromosome changes in marrow cells following exposure to low dose-rate gamma radiation is briefly discussed. Author

N63-17649 Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.

THE EFFECT OF INDUCED HYPOXIA ON THERMOREGULATION AND CARDIOPULMONARY FUNCTION

T. P. K. Lim and U. C. Luft Ft. Wainwright, Alaska, Arctic Aeromedical Lab., Jan. 1963 49 p 17 refs
(Contract AF 41(657)-330)
(AAL-TDR-62-19)

The effect of induced hypoxia on body temperature regulation and cardiopulmonary function is assessed in anesthetized dogs under warm, neutral, and cold environments. Hypoxia acts differently to heat conservation (shivering) and heat dissipation (thermal panting) mechanisms: the former is suppressed, while the latter is facilitated. It is also found that the suppression of shivering is partly due to the hypocapnia which is produced under hypoxia. The lethal threshold of acutely induced hypoxia is at the inspiratory O_2 level of approximately 3 percent in the neutral and cold environments, whereas it is at 5 percent in the warm environment. Under hypoxia, the total ventilation is increased two- to threefold. The alveolar ventilation, however, is augmented to a lesser degree with a progressive increase in physiological dead space. Contrary to respiration, the cardiac output is only slightly increased (less than 30 percent over the control value) under hypoxia. Author

N63-17650 Duke U. Medical Center, Durham, N.C.

EXPERIMENTAL STUDIES ON PROFOUND HYPOTHERMIA INDUCED AND REVERTED WITH A PUMP OXYGENATOR

M. A. Lesage, W. C. Sealy, W. G. Young, Jr., and J. M. Lee Fort Wainwright, Alaska, Arctic Aeromedical Lab., Feb. 1963 27 p 55 refs
(Contract AF 41(657)-312)
(AAL-TDR-62-30)

This report covers a summary of 300 animal experiments during profound hypothermia which stresses (1) the acceptable animal survival rate, (2) the favorable metabolic state afforded by this technique, and (3) the protective action of profound hypothermia against even severe oxygen deprivation. The technique of profound hypothermia induced and controlled with a pump oxygenator has been shown to be feasible by these studies, and has now been widely accepted for clinical application. It has become increasingly evident that, though long periods of circulatory arrest can be achieved, flow of oxygenated blood should not be stopped unless the operation demands it. The basis for this statement rests upon the observations that oxygen is utilized during profound hypothermia. Author

N63-17653 Western Reserve U. School of Medicine, Cleveland, Ohio

REVIEW OF RADIATION PNEUMONITIS

J. Chandler Smith Feb. 25, 1963 25 p 57 refs
(Contract W-31-109-eng-78)
(WRU-110)

A survey of the medical literature on radiation pneumonitis is presented with emphasis on those aspects that remain unsettled and warrant experimental investigation. Radiation pneumonitis was first recognized in 1922 shortly after the introduction of increased doses of X-irradiation for cancer therapy. Since that time, the clinical features have been clarified, the radiographic patterns have been defined, the pathologic lesions have been described, and the effects of treatment with anticoagulants and steroids have been appraised. Both the incidence and cause of radiation pneumonitis have been considered, but two important aspects remain obscure: (1) the reason that some patients develop radiation pneumonitis and others do not under seemingly similar conditions and (2) the reason that the disease process subsides spontaneously in some patients and progresses relentlessly in others. M.P.G.

N63-17666 Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio

URINARY CATECHOLAMINE RESPONSE TO WATER IMMERSION [Final] Report, [May-Nov. 1962]

Michael Mc Cally and Duane E. Graveline Mar. 1963 14 p 14 refs
(AMRL-TDR-63-20) OTS: $0.50

The urinary excretion of adrenaline and noradrenaline was measured by bioassy for 16 normal human subjects during 6 hours of complete water immersion. The excretion of adrenaline was moderately increased, possibly related to the anxiety associated with the immersion. The excretion of noradrenaline was significantly ($p < 0.01$) reduced during immersion. Six subjects were studied during passive vertical tilt following immersion. Orthostatic intolerance was demonstrated, and the increase in pulse rate and decrease in pulse pressure were significantly different from the control tilt. The probable mechanisms of the reduced noradrenaline excretion during immersion, and its relation to the postimmersion impairment of orthostatic tolerance are discussed. Author

N63-17674 Western Biological Labs., Culver City, Calif.

EFFECTS OF ANTIOXIDANTS ON RESISTANCE TO RADIATION INJURY [Final Report, Mar. 15, 1962–Jan. 30, 1963]

B. H. Ershoff and G. S. Bajwa Wright-Patterson AFB, Ohio. Biomedical Lab., Mar. 1963 32 p 21 refs
(Contract AF 33(657)-8401)
(AMRL-TDR-63-28) OTS: $1.00

Since BHT (butylated hydroxy toluene) and certain other antioxidants significantly prolonged the average survival time of mice exposed to multiple sublethal doses of total body X-irradiation, experiments were undertaken to determine the effects of antioxidants of diverse structure and activity and antioxidant synergists on length of survival following continuous exposure to a lethal dose of total body gamma radiation in the rat. BHT when fed at a 0.5% level in a purified diet and ascorbic acid at a 0.1% level significantly increased the average survival time of irradiated rats over that of rats fed the unsupplemented purified diet. Polygard (tri(nonylated phenyl) phosphites) when fed at levels of 0.25% and 0.5% and citric acid and phosphoric acid at levels of 0.1% in the purified diet also appeared to have some activity in this regard. Other antioxidants tested had little if any protective effect. The average survival time of irradiated rats was significantly longer for rats fed a natural food stock ration than for those fed the basal purified diet. No correlation was observed between the weight increment, organ weights, or microscopic appearance of the tissues of irradiated rats with length of survival on any of the diets employed. Author

N63-17687 Florida State U. Inst. for Space Biosciences, Tallahassee

EFFECTS OF THE GRAM STAIN ON MICROSPHERES FROM THERMAL POLYAMINO ACIDS

Sidney W. Fox and Shuhei Yuyama Repr. from J. Bacteriol., v. 85, no. 2, Feb. 1963 p 279–283 Presented at the Conf. on Problems of Environmental Control on the Morphology of Fossil and Recent Protobionta at the N.Y. Acad. of Sci., May 1, 1962 Previously announced as a preprint; see N63-11326 03-16
(NASA Grant NsG-173-62; NIH Grant C-3971(04))

Microspheres produced from acid proteinoid accept the Gram stain. The stain is negative, but microspheres produced from mixtures containing a sufficient proportion of lysine proteinoid stain positive. Microspheres produced from mixtures containing the appropriate proportions contain individuals which stain positive and others which stain negative. Author

N63-17701 Harvard U. Medical School, Boston, Mass.

CIRCULATION IN MAMMALIAN HIBERNATION

C. P. Lyman Ft. Wainwright, Alaska, Arctic Aeromedical Lab., Oct. 1962 48 p 57 refs
(Contract AF 41(657)-380)
(AAL-TDR-62-6)

This review of the control of circulation during hibernation begins with a general description of hibernation as it occurs in various groups of mammals, and outlines the difficulties in the physiological study of hibernation. There follows a more detailed description of the three phases of hibernation—entering hibernation, in deep hibernation, and waking from the hibernating state. The bulk of the review concerns research on rodents, which have been the most intensively studied of the animals which hibernate. It is emphasized that hibernation, at least in this group, is a precisely controlled series of physiological changes in which the animal maintains a homeostatic condition at all times in spite of profound changes in body temperature. Author

N63-17729 California U., Los Angeles. Space Biology Labs.

EEG IN SIMULATED STRESSES OF SPACE FLIGHT WITH SPECIAL REFERENCE TO PROBLEMS OF VIBRATION

W. R. Adey, W. D. Winters, R. T. Kado, and M. R. Delucchi Repr. from Electroencephalog. Clin. Neurophysiol. (Amsterdam), v. 15, 1963 p 305–320 20 refs Presented at American Electroencephalographic Soc. Meeting, Symp. on EEG in Relation to Space Travel, Atlantic City, N.J., June 1962
(NASA Grant NsG-203-62)
(NASA CR-50206)

The effects of shaking on the electrical brain activity as recorded in cortical and subcortical structures of four pig-tailed macaques (*Macaca nemestrina*) are described. Shaking was performed over a continuous spectrum from 5 to 40 c/sec, at a peak acceleration of 2 *G* over the greater part of the spectrum. Driving of brain rhythms at the shaking frequency was noted in the midbrain reticular formation, the nucleus centrum medianum, the visual cortex, and the hippocampal system. An essentially different distribution of driving was produced by photic stimulation. Control procedures indicated that this rhythmic driving was abolished or greatly reduced by pentobarbital anesthesia in both cortical and subcortical structures. It did not arise through sway artifacts in recording leads nor was it due to magnetic flux leakage in the vicinity of the shaking transducer. The driving was maximal in the frequency range

from 9 to 15 c/sec. At frequencies from 15 to 20 c/sec, evidence was found of driving at half the shaking frequency. The driving was frequently dissociated in simultaneous records from adjacent brain structures, and from leads in symmetric bilateral placements. Concurrent behavioral performance in an oddity-discrimination test indicated an increase in errors, lack of attention, and longer latency of responses at shaking frequencies around 11 c/sec, associated with maximal rhythmic EEG driving. An isolated instance of seizure induction during shaking under pentobarbital anesthesia is described. Special requirements for EEG recording in manned spaceflight are discussed.
Author

N63-17732 Naval Medical Research Inst., Bethesda, Md.
THE HUMAN THERMOSTAT
T. H. Benzinger, C. Kitzinger, and A. W. Pratt (Natl. Cancer Inst.) Repr. from Temp. Meas. Control Sci. and Ind., v. 3, Pt. 3, 1963 p 637-665 97 refs
(NASA Orders R-8 and R-38)

The human mechanisms of temperature regulation in warm and in cold environments have been resolved in quantitative terms of reproducible stimuli and responses. Cranial instead of rectal measurements were used for the internal temperature. Heat loss was measured by gradient layer calorimetry and heat production was measured by oxygen consumption. The mechanism of "physical" temperature regulation was found to consist of physiologically meaningful and reproducible sudomotor and vasomotor responses to warm stimulation of the internal thermoreceptive system. These responses were unaffected by warm reception at the skin, but cold reception did show a diminution of sweating. The mechanism of "chemical" regulation was found to respond to cold stimulus at the skin below the sweating point. It is concluded that this evidence, along with the findings of experimental surgery, indicate the presence of a "temperature-eye" in the anterior hypothalamus.
R.C.M.

N63-17737 Albany Medical Coll, N.Y.
URINE TITRATABLE ACIDITY AND AMMONIA EXCRETION DURING HYPOTHERMIA
G. S. Kanter Brooks AFB, Tex., School of Aerospace Medicine, Apr. 1963 9 p 20 refs
(Contract AF 41(657)-393)
(SAM-TDR-63-8)

Hydrogen ion secretion by the kidneys of anesthetized hypothermic dogs was measured to ascertain if the hypothermic kidney helps to compensate for the acidosis which develops during exposure to cold. Artificial respiration was not used. Total hydrogen ion excretion was measured as the sum of total titratable acid and ammonia excreted. Though anaerobic arterial pH, corrected to body temperature, fell significantly from 7.41 during control to 7.27 at 27° C, urinary pH remained at control levels of approximately 6.8. Neither titratable acid nor ammonia excretion increased in response to the hypothermic acidosis as would have occurred during normothermia with a similar low pH. Total titratable acid excretion fell from a control value of 0.011 mEq./min. to 0.005 mEq./min. at 27° C. Ammonia excretion, after a mild increase from a control value of 0.008 mEq./min., fell to 0.006 mEq./min. at 27° C. Author

N63-17986 Atlantic Research Corp., Alexandria, Va.
A STUDY OF EXPLOSIONS INDUCED BY CONTACT OF HYDRAZINE-TYPE FUELS WITH NITROGEN TETROXIDE [Final Report, June 1, 1961-May 31, 1962]
R. Friedman, W. P. Barnes, Jr., and M. Markels, Jr. Wright-Patterson AFB, Ohio, Flight Accessories Lab., Sept. 1962 36 p 8 refs
(Contract AF 33(616)-6918)
(ASD-TDR-62-685)

The mechanism of explosions which may result when a hydrazine-type liquid is brought into contact with liquid nitrogen tetroxide was studied. Falling-droplet experiments showed correlation between distance of fall and probability of explosion. Sudden injection of one liquid into the other, with high-speed photography, gave nonreproducible results. Occasional explosions occurred, preceded by bubble formation. Alternate theories of the explosion phenomenon are discussed. Author

N63-18012 Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio
NUCLEAR RADIATION GUIDE [Final Report]
Elizabeth Comfort and Jacqueline Albright, comps. Nov. 1962 245 p 636 refs
(MRL-TDR-62-61; Supersedes WADC-TR-57-118, (I and II) OTS: $3.50

Information about nuclear radiation is presented and discussed in terms of the average layman to acquaint personnel not specifically trained in the area with the problems involved in radiological protection, and as an aid to understanding this relatively new science. The following topics are treated: basic nuclear physics, biological effects of radiation, shielding methods, monitoring instruments, medical evaluation of personnel, radiation-exposure control, shipment of radioactive materials, waste disposal, and radiation-protection guides. Author

N63-18072 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
BIOCURRENTS FROM A TAPE RECORDER
V. Mikhal'chenko and S. Tsikora Oct. 30, 1962 7 p Transl. into ENGLISH from Sov. Molodezh (USSR) No. 139, July 17, 1962 p 4
(FTD-TT-62-1553-1+4)

A bioelectrostimulator, which makes it possible to control the functioning of individual neuromuscular systems and certain organs in a human being, is discussed. The stimulator uses the biocurrents of a healthy person ("donor") for the treatment of a patient. Biocurrents from the "donor," that are removed from a large peripheral nerve with the aid of electrodes and amplified many times, are directed to the same nerve in a patient, thereby causing a contraction of the paralyzed muscle and motion in the affected joint. An arm or leg, immovable up to that time, begins to act under the action of biocurrents from the "donor." Such motion is not a goal in itself. It is important that normal impulse transmission is restored, thus normalizing the metabolism in the affected organ. Bioelectricstimulation has worked well in patients suffering from poliomyelitis. It is expected that bioelectricstimulation can be extended to set in operation a heart that has stopped or normalize cardiac rhythm in the case of rapid heart beat and also to rejuvenate an organism by imposing upon it the metabolism of a young person. I.v.L.

N63-18099 Karolinska Institutet. Labs. of Aviation and Naval Medicine, Stockholm (Sweden)
HYPOXEMIA IN MAN INDUCED BY PROLONGED $+G_x$ ACCELERATION [Final Report, Aug. 1958-July 1961]
P. O. Barr and H. Bjurstedt Wright-Patterson AFB, Ohio, Biomedical Lab., Apr. 1963 15 p 26 refs
(Contract AF 61(052)-153)
(AMRL-TDR-62-137) OTS: $0.50

Changes in the arterial oxygen saturation were recorded in healthy subjects on the human centrifuge by continuous cuvette oximetry before, during, and after prolonged exposures to positive acceleration. With the subjects breathing air and wearing an automatically inflated anti-G suit, an immediate fall in the arterial O_2 saturation was observed upon exposure to +4.5 to 5.0 G_z. After one minute of the first exposure, the O_2 saturation ranged between 95 and 81 percent, the arterial pH remaining essentially unchanged. At the same time, the respiratory minute volume had increased, indicating gross deterioration in the efficiency of pulmonary function. Repeated exposures caused the arterial O_2 saturation to fall at a faster rate and to a lower level with each consecutive run. The rate of resaturation on returning to normal gravity was usually slow, and markedly so after several exposures. The last-mentioned observations are interpreted as being mainly the result of residual atelectasis in dependent regions of the lungs. The potential dangers of acceleration-induced hypoxemia in high-performance flight missions are discussed. Author

N63-18141 Cincinnati U., Ohio
RESEARCH ON THE ACCEPTABILITY OF PRECOOKED DEHYDRATED FOODS DURING CONFINEMENT [Final Report, Jan. 1962–Dec. 1962]
R. J. Senter Wright-Patterson AFB, Ohio, Biomedical Lab., Jan. 1963 43 p 1 ref
(Contract AF 33(657)-7456)
(AMRL-TDR-63-9) OTS: $1.75

The essential elements of the research involved an analysis of subjects' reactions to maintenance on a precooked-dehydrated "space rations" diet during a 28-day period of confinement. For purposes of control, a group of subjects receiving a diet composed of frozen, fresh, and heat-processed foods was used. The control foods were consistently judged more acceptable and more palatable than the same food substances presented in dehydrated form. Analyses of the data indicated that maintenance on the precooked-dehydrated diet produced no consistent effect on the psychological, physiological, psychomotor, or social functioning of the subjects under the conditions existing during the experimental sessions. Author

17 MACHINE ELEMENTS AND PROCESSES

Includes: bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control; and materials fabrication, handling, and inspection.

For related information see: 06 Auxiliary Systems.

N63-17506 Air Force Cambridge Research Labs., Bedford, Mass.
EPOXY VACUUM SEAL FOR INTRODUCTION OF LEADS INTO CRYOGENIC EQUIPMENT Research Note
Herbert G. Lipson and Lionel O. Bouthillette Mar. 1963 8 p 6 refs
(AFCRL-63-78)

A vacuum-tight replaceable seal for the introduction of thermocouple or electrical leads into cryogenic equipment is described. This seal which produces no thermal emf's at the junctions is easily constructed. Author

N63-17559 European Atomic Energy Community, Brussels (Belgium)
DESCRIPTION OF A NEW SPECIMEN-HOLDER FOR GUINIER'S X-RAY CAMERA TYPE AEG (DÉSCRIPTION D'UN NOUVEAU PORTE-ÉCHANTILLONS POUR LA CAMÉRA À RAYONS X GUINIER, TYPE AEG)
G. Bouvelle Joint Nuclear Res. Center, Ispra Estab. (Italy), Minerology and Geochem. Sect., Mar. 1963 7 p In FRENCH
(EUR-251.f) Available from Belgian American Bank and Trust Co., New York, Account No. 121.86: 25 Belg. Fr.

The described sample-holder for the multiple-camera facilitates the placement of the powdered samples. It avoids the mutual contaminations of the substances and consequently that of the diffractograms. The sample-holders are exchangeably fixed in frames, and valuable specimens may thus be kept in the prepared form. Author

N63-17560 European Atomic Energy Community, Brussels (Belgium)
DESCRIPTION OF A NEW SPECIMEN-HOLDER ANALYSIS BY CASTAING'S MICROPROBE (DÉSCRIPTION D'UN NOUVEAU PORTE-ÉCHANTILLONS POUR L'ANALYSE À LA MICROSONDE CASTAING)
G. Bouvelle and K. Weber Joint Nuclear Res. Center, Ispra Estab. (Italy), Minerology and Geochem. Sect., Mar. 1963 7 p In FRENCH
(EUR-252.f) Available from Belgian American Bank and Trust Co., New York, Account No. 121.86: 25 Belg. Fr.

This new sample holder may support irregularly formed rock and ore specimens, abraded and polished on the side, with the maximum dimensions of 18 × 32 × 10 mm^3 Author

N63-17610 Standard Pressed Steel Co. Research and Development Div., Jenkintown, Pa.
SPS CASTELOC SELF-LOCKING CASTELLATED NUTS LCN 6 – SHEAR, LCN 12 – TENSION Technical Report
Ronald Waeltz Feb. 22, 1963 34 p
(SPS Lab. Rept. 949)

The LCN 6 and LCN 12 Series SPS CASTELOC Locknuts are one-piece, all-metal castellated locknuts. The prevailing torque-type locking design provides an additional safeguard for cotter-keyed threaded fasteners. The two styles of SPS CASTELOC Locknuts, regular and thin height, are fully interchangeable with standard nonlocking castellated nuts such as the AN310 and AN320 Series. The size range of the SPS CASTELOC Locknut Series is .190-32 through .500-20. The finish is cadmium plate per QQ-P-416 Type II and, when desired, a dry film lubricant may be added. Temperature range is through 450° F. Reusability tests on cross-drilled bolts with SPS CASTELOC Locknuts, as-received and after exposure to 450° F per MIL-N-25027, showed that they are reusable for five applications. Tests also show reusability for five seated applications. Author

N63-17654 New York U. Radiation and Solid State Laboratory, N.Y.
THE EFFECTS OF HIGH ENERGY RADIATION ON INSULATORS Progress Report II, Sept. 1, 1962 through Feb. 28, 1963
Hartmut P. Kallmann Apr. 1963 10 p Submitted for Publication
(Contract DA-36-039-SC-89180)

The influence of lattice vibrations on the annihilation cross sections of positrons in insulators was studied, and methods of using persistent internal polarization to determine ionization by X-rays in anthracene crystals are reported. Results of the positron annihilation study demonstrate that, at constant volume, the annihilation rate increases as the mean square amplitudes of the lattice vibrations, so that, at high temperatures, the temperature coefficient of the annihilation rate becomes inversely proportional to the elastic constants of the lattice. Therefore, distinct effects of phase transitions on positron annihilation rates are expected in some substances. Polarization curves were obtained on anthracene single crystals by subjecting them to an electric field and concomitant X-ray irradiation for time variations from 1 to 60 minutes, and then releasing the polarization charge by ultraviolet illumination. However, part of the polarization observed appears to be partially due to some source other than X-rays. A second method requiring no external field application was devised, and preliminary results support the assumption that the difficulties encountered with the first method are related to the focusing of the X-ray beam into the polarized material. M.P.G.

N63-17683 Mechanical Technology Inc., Latham, N.Y.
INVESTIGATION OF COMPLEX BEARINGS AND/OR LUBRICATION SYSTEMS Second Quarterly Technical Progress Report, Aug. 1-Nov. 1, 1962
P. Lewis, S. F. Murray, and M. B. Peterson Nov. 6, 1962 47 p 5 refs
(Contract AF 33(657)-8666)
(MTI-62TR34)

Research on complex bearing and/or lubrication systems for flight accessory equipment that operates at temperatures from −65° F to 1500° F, in high vacuum or in normal atmosphere, and while exposed to nuclear radiation, is summarized. The rolling element system was selected as the most promising for meeting the requirements of this program. The bearing materials will be a metallic for temperatures below 1000° F, and a ceramic or carbide above 1000° F: Stellite or René 41 below 1000° F, and titanium carbide or aluminum oxide above 1000° F. Solid lubricant powders were selected for lubrication use. Thus far, powders which form molybdates, tungstates, and silicates have been selected; these reaction films form low-shear-strength adherent films. The evaluations thus far have been made on films formed by an initial application of lubricant. It will be necessary to determine the life expectancy of these films and the supply requirements. A built-in solid lubricant circulating system is felt to provide the most versatile lubricant supply system. The most critical problem is that of getting the powder into suspension. Switching from one bearing system to the other is to be accomplished by means of an expanding spacer. N.E.A.

N63-17684 Mechanical Technology, Inc., Latham, N.Y.
INVESTIGATION OF COMPLEX BEARING AND/OR LUBRICATION SYSTEMS Third Quarterly Progress Report [Nov. 1, 1962-Feb. 4, 1963]
P. Lewis, S. F. Murray and M. B. Peterson Feb. 12, 1963 45 p
(Contract AF 33(657)-8666)
(MTI-24(1-63); MTI-63TR5)

Research was conducted on the development of complex bearings and lubrication systems for flight accessory equipment that will operate at temperatures from −65° F to 1500° F, in high vacuum or normal atmosphere, and while exposed to nuclear radiation. The target specifications are for a self-contained bearing system that will operate at 30,000 rpm. Two types of materials were selected for bearing use: metals for below 100° F and ceramics for above 100° F. It appears that two separate solid lubricants will be required, one for the metal bearing and one for the ceramics bearing. For the low-temperature metal bearing, a carbon-graphite retainer looks like an interesting possibility in conjunction with molybdenum disulfide. But this system lacks protection from oxidation. In the high-temperature bearing, the complex oxides appear to be promising. The major problem in this system is to find a suitable retainer material which will provide any supplementary oxide desired and will still have suitable oxidation resistance. C.L.W.

N63-17826 Southwest Research Inst., San Antonio, Tex.
THE THREE-BALL/CONE FATIGUE TESTER
H. E. Staph and B. B. Baber [1963] 9 p 4 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VI-A, San Antonio, Tex., Apr. 16–19

This paper describes a new bench-type research fatigue tester, utilizing a cone specimen in rolling contact with a cluster of three equally spaced balls. The tester is designed to operate over a wide range of conditions of temperature, load, and speed. Other features are a closed recirculating lubrication system, the ability to vary the specimen spin-to-roll ratio, and the ability to measure torque. The paper concludes with a brief discussion of some design problems, stressing the importance of alignment. Author

N63-17827 General Electric Co., Pittsfield, Mass.
SUPERCONDUCTING FRICTIONLESS MAGNETIC BEARINGS
Donald F. Wilcock [1963] 15 p 2 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VI-A, San Antonio, Tex., Apr. 16–19

The design principles of superconducting magnetic bearings are presented in equations of interest to engineers. The load capacity per unit area of a superconducting bearing is limited by the magnetic flux density at which the superconductor will begin to break down and exhibit resistance. With the materials available today, this breakdown occurs at relatively low flux densities, but the advantages of superconducting bearings warrant the investigation of design principles and new superconducting materials. The advantages include frictionless operation within the transition temperature and critical field limits of the material, use of a closed loop superconducting coil which requires no external energy, and the dimensional stability associated with low-temperature vacuum operation. The superconducting phenomenon, the force-field relation, and the principle of the bearing support circuit are discussed. Design equations are derived for the single direction disc, the opposed disc bearing, the cylindrical bearing, and the spherical bearing. The relative performance of these different superconducting bearings is discussed and compared with that of conventional bearings. The most practical design in open loop operation is found to be a modification of the opposed disc bearing using either three or four coils. A comparison of closed loop operation of the same designs shows that the single and opposed disc designs are very similar in their load eccentricity characteristic, while the spherical bearing is appreciably less stiff. An analogy, admittedly not exact, is drawn between the flow of a lubricant through a hydrodynamic or externally pressurized bearing and the flow of magnetic flux through the superconducting bearing. M.P.G.

N63-17828 Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson AFB, Ohio
THE AEROSPACE CHALLENGE TO BEARING TECHNOLOGY
H. Digges [1963] 13 p 13 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VI-A, San Antonio, Tex., Apr. 16–19

Within the scope of this paper it is possible only to perform a cursory review of the space and reentry environment, and to concentrate upon specific requirements for a single type of bearing application. The control-hinge bearing was selected as the application for detailed treatment. Typical suborbital and superorbital reentry trajectories are presented to describe the total environment which might be encountered in the vicinity of a control bearing. The governing factors which establish functional requirements, such as coefficient or friction, internal clearance, and stiffness, are discussed. Where possible, representative values of each parameter are cited. It is concluded that control bearings must function precisely for the execution of critical maneuvers during periods of simultaneous maximum heating and loading. For single pass reentry at superorbital velocity, peak bearing temperatures in the 3000° F range are probable. Pressure levels during elevated temperature operation ranged from sea level to 10^{-4} mm Hg for the superorbital vehicles and trajectories analyzed. However, much higher vacuums in combination with high temperature are possible if the vehicle skips out of the atmosphere after the initial penetration. The capability of surviving repeated reentry cycles, and of operating after long periods of exposure to vacuums as high as 10^{-13} mm Hg will be required. Author

N63-17829 Thompson Ramo Wooldridge, Inc. TAPCO Div., Cleveland, Ohio

TRENDS IN SPACE POWER AND ANTICIPATED LUBRICATION NEEDS

P. T. Angell [1963] 9 p 4 refs Presented at the 1963 USAF Aerospace Fluids and Lubrications Conf., Session I, San Antonio, Tex., Apr. 16–19
(Sponsored by NASA; AEC; Dept. of Defense)

The important characteristics of representative turbopower systems being developed to meet the increased needs for propulsive and auxiliary power for future space missions are described; and problems and approaches to lubrication of these systems are discussed. The working fluids used in both closed or open cycle power systems are chosen on the basis of the power level and operating temperature sought. Alkali metals are preferable for higher temperature operation, but problems of heat transfer, corrosion, and structural design must be solved before systems using these fluids are available. Mercury is used at lower operating temperatures, and hydrogen-oxygen mixtures for shorter-time open-cycle applications. The requirements placed on the bearings and lubricants by closed-cycle systems are determined by considering the pressures and temperatures associated with the operating cycle. The Rankine operating cycle operates with a fluid in the temperature range where there is a liquid-vapor phase change, whereas the Brayton cycle operates with the fluid entirely in the vapor or gas phase. The use of the working fluid as the lubricant is desirable to eliminate seals and lubricate the bearings within the system pressure and temperature range. This concept dictates the use of fluid film bearings, and although some operating and application problems remain, the success demonstrated by the SNAP I/SPUD 2500 hr test and repeated endurance tests of the Sunflower turbomachine shows that there are no fundamental problems that will prevent achievement of one-year life. M.P.G.

N63-17830 General Electric Co. Flight Propulsion Div., Cincinnati, Ohio

LUBRICANT REQUIREMENTS FOR ADVANCED FLIGHT PROPULSION

D. C. Berkey [1963] 12 p Presented at 1963 USAF Aerospace Fluids and Lubricants Conf., Session I San Antonio, Tex., Apr. 16–19

The lubricant requirements of present and future jet and rocket aircraft engines are summarized. While present needs are met with existing. lubricants, future (Mach 2.5 to 3.5) engines will need fluids with improved thermal and oxidation stabilities, acceptable low-temperature viscosities, and higher spontaneous ignition temperatures. The need for a good supersonic transport engine lubricant and for a solid lubricant for extended operation above 1000° F is emphasized. D.E.R.

N63-17831 General Dynamics/Fort Worth, Tex.

ANTICIPATED LUBRICATION REQUIREMENTS FOR ADVANCED AIRCRAFT AND SPACE VEHICLE FRAMES

R. E. Adams [1963] 11 p Presented at 1963 USAF Aerospace Fluids and Lubricants Conf., Session I San Antonio, Tex., Apr. 16–19

Anticipated requirements of lubricants and lubricating systems for advanced aircraft and space vehicle frames are discussed. The general scope of lubricating problems has increased in variety, and complicating factors have arisen in terms of interaction between and variation of these variables. A space vehicle may encounter one type of corrosive environment as it leaves the earth's atmosphere on the start of its mission and be subjected during its midcourse phase to the corrosive environments of space, and much later, at the end of its mission, enter a planetary atmosphere. Associated with each one of these phases of the mission are widely varying temperatures. High-temperature requirements of lubricants and lubricating systems have grown from 165° F in the 1930's to 2500° F in the 1960's and will grow to 5000° F in the 1970's. Lubricants will need to have the capability of performing well in environments of liquid hydrogen and helium which have temperatures of −450° F and in vacuums of 10^{-10} torr to 10^{-12} torr. Longer life of lubricants will be necessitated with advanced space missions. Lubricant life requirements of three to five years will be reached in the 1970's. C.L.W.

N63-17832 Frankford Arsenal. Pitman-Dunn Labs., Philadelphia, Pa.

GREASE-TYPE LUBRICANTS COMPATIBLE WITH MISSILE FUELS AND OXIDIZERS

J. Messina and H. Gisser 13 p 13 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VII-A, San Antonio, Tex., Apr. 16–19

A thickening of mixed perfluorotrialkylamines (alkyl = C_4-C_8) with tetrafluoroethylene polymers, mol wt 2000 to 30,000, was studied in connection with the development of grease-type lubricants for liquid-fuel-powered missiles. Grease-type mixtures were obtained which were stable to shear stresses, showed no separation on standing (up to periods of one year), and showed little separation in the cone tests at 100° C. The greases were not reactive with and insoluble in ethyl alcohol, JP-4 fuel, unsymmetrical dimethylhydrazine, diethylenetriamine, a 60:40 mixture of the last two, a 50:50 mixture of unsymmetrical dimethylhydrazine and hydrazine, 90% hydrogen peroxide, and inhibited red fuming nitric acid. There was no explosive reactivity in impact tests with liquid oxygen or nitrogen tetroxide. Although N_2O_4 is somewhat soluble in the perfluorotrialkylamine, the greases showed no reactivity or observable solubility with N_2O_4, and when the N_2O_4 was permitted to evaporate from its mixture with the greases, the latter appeared unchanged. A typical grease exhibited antiwear and extreme pressure properties (4-ball tests) comparable to conventional petroleum greases, and did not attack most of the conventional elastomers. The tetrafluoroethylene polymers used had 0.20% chlorine or less. Greases made of tetrafluoroethylene polymers having 0.5 to 1.0 percent chlorine showed some reactivity with the amines. Average particle size of the polymers was 5 microns. Author

N63-17833 Pennsylvania State U. Petroleum Refining Lab., University Park

A STUDY OF THE CRITICAL PROPERTIES OF GYRO-BEARING LUBRICANTS

E. E. Klaus [1962] 13 p 7 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VII-A, San Antonio, Tex., Apr. 16–19

The purpose of this paper is to discuss the properties which appear to influence lubricant behavior under operational environments. These properties include volatility, oxidative behavior, viscosity, and boundary lubricity. Optimization of the lubricant properties for use in typical gyro bearings is discussed for superrefined mineral oil- and polyester-base lubricants. Properties of these improved lubricants are presented. The use of carefully selected lubricants is proposed as an analytical technique for the determination of the mechanism of gyro-bearing failure. Author

N63-17834 Southwest Research Inst., San Antonio, Tex.

EVALUATION OF IMPACT SENSITIVITY OF MATERIALS IN CONTACT WITH LIQUID OXYGEN AND NITROGEN TETROXIDE

F. Chang, B. B. Baber, and P. M. Ku 11 p 7 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VII-A, San Antonio, Tex., Apr. 16–19

(Contracts AF 33(616)-6232 and AF 33(616)-7223)

Tests for evaluating the impact sensitivity of liquid, grease, and solid materials in contact with liquid oxygen and nitrogen tetroxide are described. A drop-weight impact tester, basically of ABMA design, was employed; however, modifications and refinements have been made in the course of the work. Typical test results are presented and discussed. Author

N63-17835 Fairchild Stratos Corp., Bay Shore, N.Y.

POWDER LUBRICATION OF ROLLING CONTACT BEARINGS AT VERY HIGH SPEEDS AND TEMPERATURES

A. L. Schlosser [1963] 7 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VII-A, San Antonio, Tex., Apr. 16–19

(Contract AF 33(616)-6589)

Testing under high-speed and high-temperature conditions with both of the powder-lubricant mixtures revealed (usually after about 25 to 50 hours of operation) a wavy pattern on the inner-race running track. The number of wave peaks varied from ten to eighteen, and the pattern was formed without any apparent correlation to speed, number of balls, thrust-load vibration, test-rig shaft, velocity of carrier gas, or rate of lubricant feed. It is believed that the wave pattern contributed substantially to the high drive-torque requirement. The weight and compressed volume of powder lubricant, and the weight of the required quantity have been calculated to lubricate a pair of bearings for 100 hours. Author

N63-17836 Midwest Research Inst., Kansas City, Mo.

HIGH-TEMPERATURE SHEAR STABILITY OF POTENTIAL HYDRAULIC FLUIDS

V. Hopkins and D. R. Wilson [1963] 30 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session V-A, San Antonio, Tex., Apr. 16–19

(Contracts AF 33(616)-5202 and AF 33(616)-6854)

Two fluid circuits used to investigate the shear stability of potential high-temperature hydraulic fluids are described. Results of shear stability experiments conducted in both fluid circuits are presented for four potential high-temperature hydraulic fluids. Phenyl methyl silicone, bis(phenoxyphenoxy)benzene, and deep dewaxed mineral oil with TCP, PANA, and DC 200 were pumped at 3,000 psig for 100 hr in the pump stand at 550° and 700° F. Di-phenyl-di-n-dodecyl silane was pumped at 550° F only. Experiments with these four fluids were conducted in the high-temperature hydraulic circuit over a temperature range of 400° to 600° F. Only the mineral oil spanned the entire temperature range. Early pump failure was experienced at 400° F with all the other fluids except bis(phenoxyphenoxy)benzene. A 50-hr run was completed with this fluid at 400° F, but early pump failure was experienced at 500° F. Author

N63-17838 Republic Aviation Corp., Farmingdale, N.Y.

HYDRAULIC FLUIDS FOR THE SUPERSONIC TRANSPORT

Charles Spar [1963] 9 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session V-A, San Antonio, Tex., Apr. 16–19

The purpose of this program is to determine the high-temperature hydraulic fluid best suited for application in a supersonic transport. Besides being operational between −40° F and +650° F, this fluid must present a minimum of difficulties in the selection of equipment to operate with it, and, if possible, incorporate a reasonable degree of fire resistance. Author

N63-17839 Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson AFB, Ohio

AIR FORCE HYDRAULIC FLUID REQUIREMENTS AND MATERIAL DEVELOPMENTS

R. J. Benzing and William A. Marshall [1963] 13 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session V-A, San Antonio, Tex., Apr. 16–19

Hydraulic-fluid development must go hand in hand with that of high-temperature equipment, such as hydraulic pumps, to make available meaningful data for system evaluation of the new and/or improved fluids. The current program for development of a hydraulic fluid suitable for Mach 3 supersonic transport use, for example, is based on results obtained in actual system operation. It is this type of data that is essential to guide further research and development of new hydraulic fluids. At the present time, much of the projected capability of future hydraulic fluids is based only on assumptions drawn from past experience with respect to current hydraulic-fluid performance versus the physical and chemical properties of these fluids. Author

N63-17840 Bureau of Naval Weapons, Washington, D.C.

BUREAU OF NAVAL WEAPONS HYDRAULIC FLUIDS PROGRAM

H. F. Davidson [1963] 5 p 1 ref Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session V-A, San Antonio, Tex., Apr. 16–19

Hydraulic fluid research and development is reported in the following areas: (1) development of an ultralow-temperature hydraulic fluid which will operate satisfactorily in the temperature range from −90° F to +275° F; (2) improvement of the basic MIL-H-5606A petroleum fluid; and (3) development of an extreme temperature range fluid with good low-temperature (−65° F) as well as good high-temperature (+600° F) characteristics and one that is possibly nonflammable. Conventional aircraft fluids and low-temperature missile fluids were examined alone and in combination for acceptable viscosity within the temperature range (−80° F to 275° F) required for aircraft operation in the Antarctic. A blend of 55% missile fluid and 45% aircraft fluid was chosen as the most promising. The mixture was designated 1380P and was found to be satisfactory in actual service tests. A final version of the specification change proposed for MIL-H-5606A is being prepared, and some of the new requirements and test methods are reviewed. A new fluid composition synthesized basically of tetra isopropyl titanate and zinc octoate with DC 510 fluid stabilized against oxidation breakdown is in the second phase of development. This fluid exhibits excellent lubricity, excellent rubber swell properties, and very good hydraulic stability and oxidation resistance, with a fire point exceeding 650° F. Research to improve the low temperature properties of this fluid and to further improve the flame resistance by incorporating metal additives is reported. M.P.G.

N63-17841 Gulf Research and Development Co., Pittsburgh, Pa.

FACTORS AFFECTING GREASE LIFE AT HIGH TEMPERATURES AND HIGH SPEEDS

P. R. Mc Carthy [1963] 19 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session IV-A, San Antonio, Tex., Apr. 16–19

Factors which influence the lubricating efficiency and performance life of high-speed, high-temperature greases are discussed. Attention is given to the thermal and oxidative stability of the fluid and thickener components of greases since these properties seem to govern lubricating performance characteristics. Fluid components which are most satisfactory for high temperature operation are silicones, polyphenyl ethers, silphenylenes, and highly refined or hydrogenated petroleum oils. Antiwear properties were determined and of the fluid components tested the polyphenyl ethers displayed the best antiwear characteristics. Data indicated that antiwear properties are independent of temperature and dependent on viscosity. Thickeners have been found to affect the performance life of greases by: catalyzing, oxidation, or polymerization, reacting with or adsorbing inhibiters used to prolong life of the fluids, evaporating or subliming excessively, forming corrosive byproducts, and agglomerating or fusing. C.L.W.

N63-17843 Lehigh U., Bethlehem, Pa.

STRUCTURAL CHARACTERISTICS OF INORGANIC DISPERSIONS

J. J. Chessick and A. C. Zettlemoyer [1963] 10 p 14 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session IV-A, San Antonio, Tex., Apr. 16–19

Information available from extensive studies of systems based on inorganic solids dispersed in organic liquids can be used to predict the desired properties of the components of inorganic fluid–inorganic solid greases. The vehicle–solid interactions and the solid–solid interactions largely determine nonsoap grease formation and use stability under pressure and high temperature. A flocculated structure is caused by one or combinations of three factors: van der Waals' attraction between the solid particles, an immiscible component forming bridges between the particles, or soluble additives which adsorb onto the particles so as to link them together. Deflocculation factors are provided by electrical double layers on the particles, giving them a residual charge, absorbed layers leading to steric hindrance or reduced van der Waals' attraction, or solvated layers formed by adsorption of the vehicle molecules onto the solid particles. The effects of ambient moisture on the solid–vehicle interface, and of catalytic destruction of the vehicle by the solid surfaces must be considered along with abrasiveness due to the solid filler, to satisfy the required use characteristics. Author

N63-17844 Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson AFB, Ohio

AIR FORCE GREASE RESEARCH PROGRAMS

John B. Christian [1963] 7 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session IV-A, San Antonio, Tex., Apr. 16–19

The Air Force is conducting research leading to new and improved grease-like materials capable of providing lubrication under those environments and probable operating conditions imposed upon Air Force aerospace vehicles. Some of those environments and probable operating conditions being considered are high temperatures, low temperatures, high speeds, heavy loads, high pressures, deep vacuums, and extremely long periods of operation without lubrication. Author

N63-17845 Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson AFB, Ohio

HAS YOUR OIL TASTED DIFFERENT LATELY?

Kerry L. Berkey [1963] 8 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session II-A, San Antonio, Tex., Apr. 16–19

Performance efficiency and failure of aircraft engine oils are discussed. Operating problems were experienced by the T-34 turbo-prop engine on the C-133 aircraft, by the T-56 turbo-prop engine on the C-130 aircraft, by the B-52H constant speed drive, by the J-57 engine in the KC-135 aircraft, by the X-15 aircraft, and by the nozzle hydraulic pump on the J-79 engine in the F104G aircraft. All of these failures resulted from some deficiency in lubrication. The two most common causes of failure are that the oil is not suitable for the equipment and that different brands of oil are mixed in the equipment. Low-gear load-carrying ability of oils and lubricants was suggested as one of the causes for failure. The failure which occurred in the T-56 aircraft was found to result from oil-seal failure and oil jet- and screen-plugging. Design change in the oil system of the B-52H constant speed drive, which provided additional cooling, resulted in better reliability for this system. C.L.W.

N63-17846 Southwest Research Inst., San Antonio, Tex.

LABORATORY TESTS FOR EVALUATING SUPERSONIC TRANSPORT ENGINE LUBRICANTS

B. B. Baber, J. P. Cuellar, and C. W. Lawler [1963] 19 p 11 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session II-A, San Antonio, Tex., Apr. 16–19 (Contract AF 33(657)-9248)

The development of lubricant screening tests, and the evaluation of candidate lubricants for advanced gas turbine engines for the commercial supersonic transport are presented and discussed. In an effort to develop the required lubricant screening tests, strong reliance was placed on the experience gained from lubricant screening tests developed for the past and current generations of gas turbine engines, but with due recognition of future requirements. These considerations led to the decision to develop the following tests: (1) lubricant oxidation-corrosion test, (2) lubricant deposits and degradation test, (3) gear load-carrying capacity test, and (4) rolling-contact fatigue test. Results of the tests are presented. Author

N63-17847 Bureau of Naval Weapons, Washington, D.C.

NAVY TURBOSHAFT AND TURBOPROP ENGINE OIL PROGRAM

T. Mc Gee and A. Lockwood (Naval Air Materials Center, Aeronautical Engine Lab., Philadelphia, Pa.) [1963] 10 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session II-A, San Antonio, Tex., Apr. 16–19

A U.S. Navy program covering development of a specification for a synthetic lubricating oil intended for use in turboprop and turboshaft engines and helicopter transmissions is described. The viscosity of the oil is restricted to the five centistoke range (0 to 210° F), and the load-carrying capacity and high-temperature stability are established at higher levels than the current service oils. Low-temperature viscosity requirements have been established at a −40° F range in lieu of the standard −65° F range to permit use of heavier oil-base stocks. Tests for controlling shear stability and thermal decomposition are incorporated in the specification. Oils are required to pass a 100-hour bearing test under type 1.5 test conditions prior to engine testing. Author

N63-17848 Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson AFB, Ohio

ADVANCED TURBINE ENGINE LUBRICANT REQUIREMENTS

G. A. Beane, IV [1963] 5 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session II-A, San Antonio, Tex., Apr. 16–19

A change in the Air Force policy of specifying the requirements for advanced turbine engine lubricants is reported. The basic requirements are still the same (the engine oil must exhibit thermal and oxidative stability operating at bulk-oil temperatures of around 500° F), but detailed specifications on such properties as viscosity, volatility, evaporation, rubber swell, and load capacity are being abandoned. Instead, manufacturers are being invited to submit one or two candidate oils which are fluid at 0° F or lower, thermally and oxidatively more stable than MIL-L9236, and representative of the lowest deposit-forming-lubricant development by that manufacturer at the time it is submitted. The extent of evaluations to be conducted by the Air Force in cataloging these lubricants will depend on the relative merits of each oil, and the particular applications for which the lubricants appear most promising will be emphasized to the engine manufacturer. M.P.G.

N63-17849 Pratt and Whitney Aircraft, East Hartford, Conn.

SERVICE EVALUATION OF SYNTHETIC LUBRICANTS

H. W. Reynolds, Jr. [1963] 13 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session II-A, San Antonio, Tex., Apr. 16-19

Methods of evaluating synthetic lubricants for aircraft turbine engines are reviewed. Increases in engine performance often adversely affect a lubricant's environment, and in some of the late-model, high-performance turbojet engines, current lubricants appear to be reaching their useful thermal and oxidative stability limits. Methods used to screen lubricants include: (1) laboratory tests of certain key oil properties such as viscosity, acidity, and lead corrosion characteristics; (2) rig tests, using devices, such as bearing rigs, to evaluate variations of oil viscosity with time as a function of temperature; gear rigs to measure the load-carrying ability or scuff resistance; and carbon seal wear test rigs; (3) stationary engine tests to obtain an indication of lubricant performance on the basis of oil system deposits, lubricant fluid degradation, and oil-related engine mechanical durability problems; and (4) field service tests in a limited number of airline flight engines. A new approach to monitoring flight engine lubricants is based on the changes in electrical conductivity of used synthetic lubricants related to the electrical conductivity of the same oil in the unused condition. A luberater device has been developed which uses an aluminum cup as both the sampling and testing container. The cup can be mailed in its own cardboard tube, thus speeding the conductivity analysis of oil samples taken from flight engines at various operating time intervals. M.P.G.

N63-17850 British Petroleum Co., London (Gt. Brit.)

SOME DEVELOPMENTS IN THE FORMULATION AND ASSESSMENT OF ESTER BASED HIGH TEMPERATURE AERO GAS TURBINE LUBRICANTS

N. Hunter [1963] 3 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session II-A, San Antonio, Tex., Apr. 16–19

Results obtained in high-temperature oxidation, panel coker, and bearing tests of three inhibited-hindered (hydrogenless) ester-type lubricant oils are discussed so as to determine the influence of the preparatory method and the nature of the additive package used to fortify the base oil. The gross chemical structures of the three esters are identical, but they contain different additives and were prepared by different methods. The lacquer and film deposits formed with each oil are compared and their performance under conditions of extreme temperature and in the presence of magnesium evaluated. The performance of one oil, developed to conform to British DERD 2497 specifications, is found to be an advance over that of other ester-based oils. Attention to structural detail in such oils is recommended to improve both the thermal and oxidative stabilities without excessive loss of other valuable properties. D.E.R.

N63-17851 Rocketdyne, Canoga Park, Calif.

ALKALI METAL LUBRICATED JOURNAL BEARING EXPERIMENTS APPLICABLE TO SPACE POWER SYSTEMS

J. Hall and R. S. Siegler [1963] 25 p 6 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session II-B, San Antonio, Tex., Apr. 16–19
(Contract AF 33(616)-8328)

Performance data have been obtained with various one-inch-diameter, pressure fed, self-acting bearings lubricated with potassium under the following operating conditions: potassium temperature to 1000° F, journal speeds to 36,000 rpm, and loads to 56 lbs. The performance data have been correlated with theoretical predictions, and good agreement has been obtained in the laminar regime, while correlation to the limited data in the turbulent regime is reasonable. Tests were conducted with room-temperature water as the lubricant, as a means of calibrating and checking the alkali-metal test bearings. Endurance tests have been conducted on one-inch-diameter, pressure fed, self-acting bearings. Results of the tests are presented. Author

N63-17852 Mechanical Technology, Inc., Latham, N.Y.

A REVIEW OF TURBULENT LUBRICATION THEORY FOR LIQUID METAL LUBRICATED JOURNAL BEARINGS

E. B. Arwas and B. Sternlicht 13 p 16 refs [1963] Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session II-B, San Antonio, Tex., Apr. 16–19

This paper summarizes the problems of liquid-metal lubricated bearings that are associated with the hydrodynamics of the fluid film. At the speeds required of compact space-power turbomachinery, these bearings operate in turbulent regime. The major differences between laminar and turbulent lubrication are discussed. Recent advances achieved in turbulent lubrication analysis are described, and needed future theoretical and experimental studies are outlined. Author

N63-17853 Aeronautical Systems Div. Air Force Systems Command, Wright-Patterson AFB, Ohio

REVIEW OF LIQUID METAL LUBRICATION RESEARCH PROGRAMS

J. L. Morris [1963] 9 p 6 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session II-B, San Antonio, Tex., Apr. 16–19

Simplicity and minimum weight are maintained in space power-conversion systems by using the liquid-metal working fluids as hydrodynamic bearing lubricants. This concept has been proven feasible by a number of experiments at expected system conditions. Author

N63-17854 General Electric Co. General Engineering Lab., Schenectady, N.Y.

COMPARISON OF NO LOAD, STATIC FLUID FILM STIFFNESS AND LOAD CARRYING CAPACITIES AMONG SEVERAL BEARING TYPES

J. D. Mc Hugh [1963] 25 p 15 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session II-B, San Antonio, Tex., Apr. 16–19
(NASA Contract NAS3-2111)

A comparison of the stiffness of different kinds of bearings under zero load conditions has been made. In order to form a fair basis of comparison, it is first necessary to establish a common design denominator among the bearing types. This has been done by comparing bearings which at zero load have the same minimum clearances between the shaft and bearing. A further criteria is obtained by comparing the load capacities of such bearings for a specified minimum film thickness and load direction. With such a basis of comparison among the bearings studied, it is found that the four pad, tilting-pad bearing studied has the highest static stiffness at zero load, at a bearing length/diameter ratio of one-half. The calculated value, in fact, is greater than the stiffness for the other bearing types at twice the L/D studied for the four-pad bearing. Moreover, as shown in the load comparison, the load capacity is comparable to that of the three-lobe bearing, and at least one-half that of the two axial groove bearing. Thus, on the basis of these two criteria, the tilting-pad bearing is the most attractive. Author

N63-17855 Koppers Co., Inc. Metal Products Div., Baltimore, Md.

EVALUATION OF SEAL-LUBRICANT DEPOSIT FORMATIONS UNDER HIGH TEMPERATURE CONDITIONS

R. B. Spooner, J. S. Lagarias, and B. D. Pfoutz [1963] 18 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session III-A, San Antonio, Tex., Apr. 16–19

The ASD Seal-Lubricant Rig was modified to give it the capability of reaching the high operating temperatures ultimately expected in main-shift rotating air-oil seals of high Mach number gas turbine engines. On this rig, various operating methods were studied in an effort to develop repeatable methods in a stepwise approach to the ultimate high temperatures. Repeatable methods were developed for 750° F air temperature and 300° F bulk-oil temperature and, most recently, for 1050° F air temperature and 425° F bulk-oil temperature. Resulting operation at the last condition correlates well with engine test data at similar high temperatures. Author

N63-17856 Aeronautical Systems Div. Air Force Systems Command, Wright-Patterson AFB, Ohio

ENGINE PERFORMANCE VERSUS LUBRICANT DEPOSITS

L. J. De Brohun [1963] 6 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session III-A, San Antonio, Tex., Apr. 16–19

Lubricant deposit tests are being run on candidate lubricants for specification MIL-L-9236. The final acceptance tool is a J-57-59 engine which is rigged to stress the oils at a 425° F bulk temperature. Both the Wadd No. 4 bearing rig and the 100 mm Erdco bearing rig have been used for screening applicant lubricants for final testing. Data collected with both these rigs show a better correlation between the Erdco Rig and the J-57-59 engine. It is anticipated that this rig will be used as a basic tool for evaluating candidate oils for advanced turbine engine designs. R.C.M.

N63-17857 Aeronautical Systems Div. Air Force Systems Command, Wright-Patterson AFB, Ohio

MATCHING FLUID PROPERTIES WITH PROJECTED LUBRICANT REQUIREMENTS

F. J. Harsacky [1963] 8 p 5 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session III-A, San Antonio, Tex., Apr. 16–19

The processes in the development of new, advanced gas turbine engine oils are reviewed. There are essentially five steps to the production phase of development. First, there is the basic research on new compounds performed in the chemistry laboratory. Secondly, the fluids are evaluated as to their physical, chemical, and additive properties. Thirdly, the potential lubricant is tested in a simulated engine environment. Fourthly, static engine tests are run. Finally, the lubricant is tested in flight in actual performing engines. Acceptable levels are given for the important lubricant properties, and the current status of liquid lubricant development is summarized. D.E.R.

N63-17858 Socony Mobil Oil Co., Inc., Paulsboro, N.J.

THIN FILM OXIDATION TEST

E. A. Oberright and H. L. Hepplewhite [1963] 10 p 4 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session III-A, San Antonio, Tex., Apr. 16–19
(Contract AF 33(616)-8021)

A High Temperature Thin Film Oxidation Unit has been constructed, and test repeatability and reproducibility have been established. This equipment offers a means of measuring the oxygen absorption and maximum deposit-free temperature of operation of a lubricating oil under highly oxidative conditions for short contact times. Six high-temperature oils, supplied by ASD, have been evaluated in this equipment, and maximum deposit-free temperatures determined. Relative ratings based on cleanliness, developed by ASD from Bearing Rig and/or Engine Test data, are in agreement with test results at 575° to 600° F in the High Temperature Thin Film Oxidation Unit. Author

N63-17859 Alcor, Inc., San Antonio, Tex.

A NEW DEPOSITION TEST FOR PREDICTING ENGINE DEPOSITS AND OIL DEGRADATION

H. G. Buschfort and A. Hundere [1963] 9 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session III-A, San Antonio, Tex., Apr. 16–19

Dynamic tests, duplicating as closely as possible the thermal and oxidation stresses in a typical jet engine, were conducted on lubricants. The objective of these tests was to devise methods of predicting engine deposits and oil degradation. Data were presented on the effect of residence time and airflow on fourteen oils of different types. The residence time was varied by changing the diameter of the outer tubes of the heater used for the tests. It was found that residence time and airflow had a pronounced effect on the relative rating of lubricants with respect to oil degradation. At the low residence time, 2.3 seconds and 1000cc/min airflow, good correlation with engine data was obtained. At this condition it was assumed that the residence time and air and oil contact simulate that in the engine. Of the fourteen oils tested, twelve correlated with the engine within ±10%. It was concluded that this new deposition test will predict engine deposits with a reliability of 80% and will predict oil degradation with nearly the same accuracy. C.L.W.

N63-17860 MSA Research Corp., Callery, Pa.

THERMOPHYSICAL PROPERTIES OF RUBIDIUM AND CESIUM

F. Tepper, A. Murchinson, and J. Zelanak [1963] 13 p 36 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session III-B, San Antonio, Tex., Apr. 16-19
(Contract AF 33(657)-7659)

The determination of the thermophysical properties of rubidium and cesium at temperatures up to 2000° F is part of a larger program designed to determine the properties of alkali metals. Determinations are completed for the vapor pressure of rubidium and density of the liquid. Determination of the specific heat of liquid rubidium and the PVT of the vapor are in progress. For the vapor pressure, 56 data points are listed along with regression line values, the temperature and the percent deviation of each point from the regression line. Sixty density data points, in the range 150° F to 2000° F, are listed in the order of increasing temperature. N.E.A.

N63-17862 Southwest Research Inst., San Antonio, Tex.

RECENT DATA ON THE THERMOPHYSICAL PROPERTIES OF ALKALI METALS

W. D. Weatherford, Jr. [1963] 12 p 27 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Cong., Session III-B, San Antonio, Tex., Apr. 16-19
(Contract AF 33(657)-8657 and AF 33(657)-9457)

This paper reviews the recent data on the thermophysical properties of the alkali-metal fluids, cesium, rubidium, potassium, sodium, and lithium. Correlation of these data suggests areas of doubtful accuracy, and illustrates certain anomalous properties of sodium. Author

N63-17864 Mechanical Technology, Inc., Latham, N.Y.

DYNAMICS OF GAS BEARINGS IN AEROSPACE MANEUVERS

B. Sternlicht [1963] 22 p 19 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session IV-B, San Antonio, Tex., Apr. 16-19
(Sponsored by ONR)

A review of the dynamics of rotor-bearing systems for space applications is presented. Several types of system instability that originate in gas lubricated bearings are defined and the bearing fluid-film forces are determined. The dynamic phenomena considered include critical speed, synchronous whirl, half-frequency whirl, fractional-frequency whirl, and pneumatic hammer oscillation in the flow system. Some effects of rotor-bearing geometry on instability are examined. Experimental results reported for synchronous whirl and half-frequency whirl agree with theoretical predictions. The conditions for initiation of destructive self-sustained whirl in hybrid bearings are established, and the effects of an increase in load on the onset of fractional-frequency whirl are related to high and low supply pressures. M.P.G.

N63-17865 Franklin Inst., Philadelphia, Pa.

RECENT PROGRESS ON THE DEVELOPMENT OF GAS-LUBRICATED BEARINGS FOR HIGH SPEED ROTATING MACHINERY

E. J. Gunter, Jr., and D. D. Fuller [1963] 21 p 13 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session IV-B, San Antonio, Tex., Apr. 16-19
(Contract AT(30-1)-2512)

Problems that may be encountered when high-speed rotors are operated on gas-lubricated bearings are reviewed. All gas-lubricated bearings have common characteristics of low damping and relatively low spring rates. Rotor dynamics are strongly affected by these characteristics. Therefore, this paper reviews the influence of gas-lubricated bearings on balance requirements, critical rotor speeds, and the susceptibility of the rotor system to external excitation, especially when near a critical speed. The tilting-pad journal bearing shows much promise for high-speed rotor applications, and a comparison between theoretical and experimental performance is given for load-carrying capacity and optimum pivot position. The agreement between measured and predicted values of film thickness is good. Author

N63-17866 Naval Air Experimental Station. Aeronautical Materials Lab., Philadelphia, Pa.

THE EFFECT OF THE CHEMICAL COMPOSITION OF METALS IN SOLID LUBRICATION

M. J. Devine, E. R. Lamson, and J. H. Bowen, Jr. [1963] 15 p 18 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session V-B, San Antonio, Tex., Apr. 16-19

The relationship of alloy constituents and chemical composition of lubricating solids in the processes of lubrication have been explored to establish basic concepts. The lubrication characteristics displayed by metallic sulfides as a class of compounds for molybdenum metal, and the significance of metal composition for surfaces having sliding contact in bearings operating at 10,000 rpm and 750° F is described. Experimental results for a bonded solid-film lubricant under these conditions of speed and temperature provided 1100 hours of wear life. A description of a vacuum system designed to operate at pressures in the range of 1×10^{-6} mm Hg, and at temperatures as high as 1000° F is shown, as well as results of studies conducted under the combined vacuum and temperature environment. Author

N63-17867 Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson AFB, Ohio

SOLID FILM LUBRICANT DEVELOPMENT FOR AIR FORCE REQUIREMENTS

B. D. Mc Connell [1963] 11 p 7 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session V-B, San Antonio, Tex., Apr. 16-19

The requirements and capabilities of lubricants for use in aircraft, missiles, and other weapon systems are discussed. These requirements include operation at high temperatures in both oxidizing environments and vacuums (10^{-6} torr). The crystal properties of solid lubricants, with concentration on single crystals of graphite, were studied along with the phase changes and reactions which take place in a ceramic-bonded solid-film lubricant at different temperatures. Different bonding techniques were also studied. Measurements of the cohesive energy between layers of mica and graphite were conducted; data indicated that there is a thirtyfold increase in the energy required to separate the layer in vacuum (10^{-13}torr) as in air. Helium, argon, and nitrogen were found to have no effect on the cohesive energy, but water vapor was found to cause separation of layers at a pressure of 10^{-1} torr. The PbS-B_2O_3 lubricant was investigated, and the B_2O_3 was found to govern the frictional and lubricating behavior of this lubricant. The data gathered from the study of this lubricant will allow selection of materials having the specific properties needed to formulate superior high-temperature solid-film binders. Tests were conducted on ceramic adhesives, and the results indicate the possibility of obtaining formulations of high-temperature adhesives and lubricating pigments which may have potentiality as solid-film lubricants. C.L.W.

N63-17868 Midwest Research Inst., Kansas City, Mo.

FRICTION AND WEAR CHARACTERISTICS OF A CERAMIC-BONDED SOLID-LUBRICANT FILM

M. T. Lavik and W. L. Clow [1963] 9 p 4 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session V-B, San Antonio, Tex., Apr. 16-19

This paper summarizes friction and wear studies of the $PbS{:}MoS_2{:}B_2O_3$ lubricant system. A review of the film preparation and evaluation techniques used in the investigation is given. The wear-life and friction performance of the films in this system are discussed. In electron micrography of film surfaces, consideration is given surface films rubbed in air and surface films rubbed in a vacuum. Results of the film performance show that (1) the film wear-life is very good in air over a limited temperature range near 1000° F and friction coefficients remain below 0.20; (2) the films exhibit useful wear and friction properties over the temperature range 80° to 1000° F in both air and vacuum ($\sim 10^{-6}$ Torr). The wear-lives are proportional to e^{-cT} and are approximately 300 percent longer in vacuum than in air. Film structure results show that (1) the films rubbed in air at 700° F exhibit much more severe and extensive wear areas than similar films rubbed in vacuum; (2) the wear patterns of film rubbed at 700° F in vacuum are composed of closely spaced rub marks in the film areas still intact; few areas of severe wear are noted; (3) films rubbed at 1250° F in vacuum exhibit diffuse rub marks and relatively large-scale plastic deformation. N.E.A.

N63-17870 Midwest Research Inst., Kansas City, Mo.

THE VISCOSITY AND DENSITY OF FLUIDS AT HIGH PRESSURES

D. R. Wilson and F. J. Barker [1963] 13 p 25 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VI-B, San Antonio, Tex., Apr. 16–19
(Contracts AF 33(616)-5202 and AF 33(616)-6854)

Methods of measuring viscosity, and the advantages of a form of the "falling-weight" viscometer for high-pressure work are discussed. A falling-cylinder viscometer, designed for operation to 250,000 psig and 4000° F, is described. Liquid density, bulk modulus, and "freezing" points, of electrically nonconducting liquids can be measured in addition to the viscosity determinations. The method used in calibrating a manganin pressure sensor to 108,600 psig is outlined. Author

N63-17872 General Motors Corp. New Departure Div., Bristol, Conn.

GAS/BALL BEARINGS. A STUDY OF THEIR INHERENT DAMPING CHARACTERISTICS

R. E. Maloney and F. J. Jain [1963] 12 p 6 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session IV-B, San Antonio, Tex., Apr. 16–19

A special type of self-acting gas lubricated ball bearing was investigated for the purpose of showing, through optical displacement measurement, that the fixed mounting conditions assumed in the theoretical analysis of half-frequency whirl do not exist in the gas/ball bearings, and also to compare experimental results on gas/ball bearings with work done by others on conventional bearings. In the apparatus used for the tests, the rotors consisted of 0.5000-in.-diameter shafts, 7.875 in. long, and a 1.2500-in.-diameter aluminum turbine. The bearings used were nominal 0.5000 bore with a 0.3125 length and were round and taper-free, within 0.000005-in. Two basic types of test were conducted: (1) with the rotor vertical and (2) with the rotor at 45 degrees. Conclusions reached are that: (1) gas/ball bearings do not exhibit one-half whirl at speeds substantially higher than the theoretical threshold of half-speed whirl in conventional gas bearings; and (2) the continuous following motion of the gas bearing acting on stiff springs (the balls) provides damping. N.E.A.

N63-17873 Southwest Research Inst., San Antonio, Tex.

THERMAL ASPECTS OF CONTACT FATIGUE UNDER OSCILLATORY NORMAL LOAD

R. A. Burton, J. C. Tyler, and P. M. Ku [1963] 17 p 11 refs Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VII-B, San Antonio, Tex., Apr. 16–19
(Contract NOw-60-0404-C)

Experiments are reported wherein contact fatigue was brought about by the application of an oscillatory normal load between a ball and a flat specimen. Curves of flat specimen temperature versus time showed that a rapid temperature rise occurred in the initial stage of crack formation rather than after the appearance of fully developed spalls; thus the temperature criterion appeared to provide an early indication of fatigue. Fatigue failure was observed in unlubricated as well as lubricated contact, but with much longer life when unlubricated. Toroidal rings of hardened and softened material were noted both on and below the contact surface. These hardness variations bore symmetrical relationship to the contact geometry and were apparently related to the stress pattern. It was found that the fatigue cracks did not initiate in the most severely hardened material, but in the material adjacent to it. Further, the slope of the cracks tended to follow the boundary of the hardened region in general direction. Author

N63-17874 Marlin-Rockwell Corp., Jamestown, N.Y.

HIGH TEMPERATURE OIL EVALUATION IN FULL-SCALE BEARING FATIGUE TESTS

J. H. Gustafson [1963] 8 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VII-B, San Antonio, Tex., Apr. 16–19

Oils and lubricants were investigated for possible use in jet engines. Experimental mineral-oil compounds, ester-base synthetics, trimethylol propane ester, and polyphenyl ether were evaluated for their effect on bearing fatigue life. A jet-engine main-shaft-thrust location bearing, with speeds equivalent to normal engine speeds, was utilized in the testing. Bearing loads and oil temperatures were increased to duplicate the expected severity of advanced engines in which these lubricating fluids would be used. In the initial tests at 13,000-lb bearing load, oil-in temperature was controlled at 400° F with a resulting bearing temperature of 525° F. Additional tests were conducted at 18,000-lb bearing load which resulted in a bearing temperature of 550° F. Although actual bearing fatigue did not occur, valuable information on the stability of two of the fluids was obtained. Trimethylol propane ester and polyphenyl ether resulted in high evaporation losses but both fluids displayed good thermal stability. Poor oxidation stability and excessive volatization of the mineral compounds and ester-base fluids were evidenced by the increase in viscosity and acid number. After twenty-four hours of testing, these fluids had deteriorated to the point where they were no longer usable. C.L.W.

N63-17875 Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson AFB, Ohio

AIR FORCE BEARING FATIGUE PROGRAM

G. A. Beane, IV [1963] 5 p Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VII-B, San Antonio, Tex., Apr. 16–19

While there are no bearing-fatigue problems known to be occurring in present aircraft, the Air Force has undertaken a broad and long-range program to determine the influence of lubricants on bearing fatigue life. This program includes determination of thin-film lubricant rheology properties within the rolling contact region, evaluation of bulk pressure viscosity characteristics, development of simplified bench tests for studying the effects of operating variables and predicting full-scale bearing fatigue life, and full-scale bearing evaluation of the fatigue life of select lubricants of known composition which can be made readily available whenever needed in the future. By providing a common relationship between the various program phases, such as by using identical test-specimen materials and lubricants, it is felt that the resulting package of information will add substantially toward gaining an increased knowledge of the role lubricants play in affecting bearing fatigue life. Author

N63-17876 Battelle Memorial Inst., Columbus, Ohio
THE RHEOLOGICAL BEHAVIOR OF THE LUBRICANT IN THE CONTACT ZONE OF A ROLLING CONTACT SYSTEM
J. C. Bell, J. W. Kannel, and C. M. Allen [1963] 21 p 15 refs
Presented at the 1963 USAF Aerospace Fluids and Lubricants Conf., Session VII-B, San Antonio, Tex., Apr. 16–19
(Contract AF 33(616)-7257)

A technique has been developed for studying the rheological behavior of the lubricating film within the contact zone of rolling-contact bodies. This is accomplished by rolling two contacting disks together with a small amount of sliding superimposed on a relatively high rolling velocity. By measuring the traction, slip-rate, and the lubricant film thickness in the elastically deformed contact, a plot of traction versus mean shear rate can be made. Data are presented for polyphenyl ether. The data depend on the disk temperature and contact pressure qualitatively as would be expected, but the observed dependencies on shear rate and rolling speed require explanation. Analysis of possible local thermal disturbances on the lubricating film, assuming a Newtonian lubricant model, indicates that, for the experiments described here, temperature changes only partially explain the observed nonlinear variations of traction with shear rate, and fall far short in accounting for variations with rolling speed. A study assuming isothermal conditions and Ree–Eyring lubricant model provides a traction theory which is flexible enough to fit the variations with shear rate, if certain parameters have advantageous values, but which appears only partially able to correlate the variations with rolling speed. Thus additional analyses which consider, say, both non-Newtonian and thermal effects, or perhaps other entities, are necessary for interpreting the data. Author

N63-17910 Harry Diamond Labs., Washington, D.C.
A CAPSTAN-TYPE TORQUE REGULATOR FOR TIMING MOVEMENTS
David S. Bettwy May 31, 1963 16 p
(TR-1130)

A capstan type of torque regulating device is described, and test results of its application to a runaway timing movement are presented. Author

N63-17943 Grumman Aircraft Engineering Corp., Bethpage, N.Y.
BETA RADIATION METHOD OF THICKNESS MEASUREMENT
Dennis Becker Dec. 1, 1962 21 p 7 refs
(ADR-09-06b-62)

The application of beta absorption to the measurement of a coating thickness upon a base material was investigated. Specimens of copper-coated fiber glass were used. A method of nondestructive thickness measurement was developed. Author

N63-17945 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
A GENERAL STUDY OF PROCESSES FOR THE REALIZATION OF DESIGN CONFIGURATIONS IN MATERIALS Fourth Interim Technical Report, Nov. 3, 1962–Apr. 3, 1963
Paul Rosenthal Wright-Patterson AFB, Ohio, Manufacturing Tech. Lab., Apr. 1963 93 p 40 refs
(Contract AF 33(600)-42921)
(CAL-NM-1559-P-4; ASD-IR-4)

General guidelines for process synthesis are developed, based on the material properties, topological characteristics of the processes, the energy transformation involved, and the environmental conditions essential to the energy transfer. Two general approaches to improving material-removal processes are cited: the first is concerned with reducing surface energy by environmental means, the second with modification of the geometery of the failure mechanism, so as to reduce the energy required. Material removal processes synthesis includes microscopic and macroscopic aspects of relaxation and resonance in materials, cavitation, and chemical removal. The approach to improving the joining processes is directed at the control of surface preparation, and the removal of the energy released due to reduction of total surface area. Examples presented include the category of diffusion bonding processes, means for achieving shape control in vapor deposition, and a process category in which a liquid medium is temporarily interposed between the mating surfaces. Improved material displacement processes are shown to result—from the energy point of view—from reduction in the number and distances of discrete particle displacements necessary for the process. Synthesis is discussed on macroscopic and microscopic levels. As a hypothetical example, a displacement process involving combinations of magnetic, thermal, and electrical energy is outlined. Author

N63-18023 Cornell Aeronautical Lab., Buffalo, N.Y.
PROJECT NEOS: A GENERAL STUDY OF PROCESSES FOR THE REALIZATION OF DESIGN CONFIGURATIONS IN MATERIALS Interim Technical Progress Report No. 3, 3 Apr. 1962 to 3 Nov. 1962
Paul Rosenthal Wright-Patterson AFB, Ohio, Manufacturing Tech. Lab., Nov. 1962 118 p 60 refs
(Contract AF 33(600)-42921)
(CAL-NM-1559-P-3; ASD-IR-3)

The role of electric and magnetic fields as primary and as auxiliary energy sources is explored; to support the assessment of new and established applications, calculations of the forces, stresses, and energy and power densities are made. Electron, ion, and laser beams are compared, and their potential roles in material removal and material addition process are discussed. The mechanism by which electron beams penetrate materials, and the power densities that are achievable are treated at some length. The embrittlement mechanisms are evaluated systematically. The effect of strain rate and temperature on material properties is investigated. The magnitude of strain rates in several manufacturing processes is calculated, and the concept of strain acceleration is explored. Direct deposition processes are classified, and achievable mechanical properties and prospects of configuration control are discussed. Deformation processes are treated from the point of view of dislocation theory. Author

N63-18026 Cornell Aeronautical Lab., Inc. Buffalo, N.Y.
PROJECT NEOS: A GENERAL STUDY OF PROCESSES FOR THE REALIZATION OF DESIGN CONFIGURATIONS IN MATERIALS Interim Technical Progress Report [No. 2] 3 Oct. 1961 to 3 Apr. 1962
Paul Rosenthal Wright-Patterson AFB, Ohio, Manufacturing Tech. Lab., Apr. 1962 86 p 26 refs
(Contract AF 33(600)-42921)
(CAL-NM-1559-P-2; ASD-IR-2)

Following the previous development of a generalized concept of the manufacturing process, and its classification according to form of energy, mode of energy transfer, environment, and process topology, results of parallel studies within the framework of these process elements are reported. These studies have been of two kinds: (1) broad studies of entire categories, such as material addition by solid-state bonding, and (2) feasibility studies of promising effects, such as increasing the ductility of certain brittle materials under the influence of electric fields. A table of criteria for the evaluation of processes has been developed, and six established and candidate processes have been entered. Author

N63-18087 Frankford Arsenal, Philadelphia, Pa.
THE PROCESSES AND DEVELOPMENT OF TECHNIQUES OF MINIATURIZED GOLD PLATED THROUGH HOLES IN PRINTED CIRCUITS
Robert P. Hogan and Bernard Stepanski May 1963 27 p 8 refs
(PP-T-9672-1)

This report describes the techniques developed and the procedures used successfully copper, nickel, and gold plating small (0.040", 0.031", 0.020" and 0.016") diameter plated, through holes utilized as interface (side-to-side) connections in double-sided printed cirucit boards. Author

N63-18121 Massachusetts Inst. of Tech. Instrumentation Lab., Cambridge
Monthly Progress Report [BEARING-YIELD AND LIFE-IMPROVEMENT PROGRAM]
Alfred C. Edwards May 1963 17 p
(Contract AF 33(657)-7463)
(Rept. 16; E-1349)

Progress in a bearing-yield and life-improvement program is reported. Screening tests of base line and accelerated performance of bearings were conducted. Improved retainers made of high porosity Synthane materials have been screened, and unsteady bearing operation was alleviated by reducing the total lubricant quantity by extraction with either 99% or 90% Freon with V-78 oil. Screening starts have been made with ND gyro oil G, and satisfactory life tests of ND gyro oil D terminated at about 245 hours, approximately twice the best life of other lubricants under similar test conditions. The ball lapping process has been used to produce improved finish and design B races. Sets of design A improved bearings are being screened with groove-riding and O.D. retainers. Studies of retainer dynamic behavior were made to correlate wattmeter response to small and large amplitude variations and to determine the effect of shaft interference on bearing performance. Results of a second series of tests on improved lubricants are reported. M.P.G.

N63-18122 Massachusetts Inst. of Tech. Instrumentation Lab., Cambridge
Monthly Progress Report No. 9, September 1962 [BEARING YIELD AND LIFE-IMPROVEMENT AND THERMOELECTRIC COOLING PROGRAM]
Alfred C. Edwards Oct. 1962 24 p 2 refs
(Contract AF 33(657)-7463)
(E-1222)

Progress is reported in a bearing-yield and life-improvement program and in a thermoelectric cooling program. Fourteen pairs of bearings failed when subjected to base-line screening tests. Mercury porosimeter tests were run on three Synthane variations, and V-78 oil was tested on a single bearing test machine. Ball lapping and honing of races were investigated, and the results prompted the decision to use optimized honed races in the basic factorial test plan. The effects of pretreating bearings with organic coatings were investigated, and the relationship between the electrical resistance between a pin and disc rotating at various speeds and the observed wear was studied. Screening tests of super-refined lubricants are being conducted, and two pairs of bearings are still running in an accelerated life-testing program. Life tests on individual bismuth telluride cooling modules have continued, and static and running tests of annular bearing cooling modules were made to evaluate insulating materials, bearing support methods, and airflow through the motor and over the hot sink heat radiator. The effect of temperature on bearing life and performance is being studied in an evaluation of practical cooled bearing systems. M.P.G.

N63-18124 Massachusetts Inst. of Tech. Instrumentation Lab., Cambridge
Monthly Progress Report No. 13, January 1963 [BEARING YIELD AND LIFE-IMPROVEMENT PROGRAM AND THERMOELECTRIC COOLING PROGRAM]
Alfred C. Edwards Feb. 1963 18 p
(Contract AF 33(657)-7463)
(E-1312)

Progress is reported in screening sets of bearings in a bearing-yield and life-improvement program. The base-line and accelerated performance tests were conducted primarily with ND gyro oil D. Data were obtained on variations of ball-retainer Synthane material oil impregnation and desorption characteristics, and on abrasive tumbling finishes for bearing races. Fabrication of design A and design B improved bearing parts is progressing. Two inner-race rotating bearings were observed in an unstable operating condition in a gyro wheel, and a theoretical evaluation of the instability is presented. The effects of lubricant viscosity and of pretreatment of the metal surfaces with organic coatings were evaluated. The major problem at the present time is evaluation of the effect of surface discontinuities. Work on the thermoelectric cooling program is nearing completion. M.P.G.

N63-18144 Pratt and Whitney Aircraft, East Hartford, Conn.
RESEARCH AND DEVELOPMENT OF TITANIUM ROCKET MOTOR CASE Tenth Quarterly Report, Oct. 1-Dec. 31, 1962
H. A. Hauser and W. E. Helfrich Jan. 31, 1963 79 p
(Contract DA-19-020-ORD-5230)
(PWA-2156; WAL-TR-766.2/1-9)

The results of work on the research and development of high-strength, lightweight titanium alloy rocket case include: (1) smooth and notched tensile properties of flow-turned material with hydrogen contents of 70 and 200 ppm; (2) results from cyclic loading and tensile testing of B-120 VCA titanium alloy TIG welds; (3) tensile and hardness data for Ti-6Al-6V-2Sn alloy TIG welds; (4) smooth and notched tensile data for 40-inch-diameter roll-forged rings re-solution treated at 1800° F; (5) smooth and notched tensile properties of 14- and 40-inch-diameter flow-turned cylinders; (6) tensile properties of 40-inch-diameter rear dome press-forged in closed dies at 1750° F; (7) results from hydrostatically burst testing full-scale component assemblies, one containing a flow-turned cylinder, and the other a press-forged rear dome; and (8) bend- and tensile-test data for Ti-15 Mo alloy sheet stock. Author

N63-18159 General Electric Co. Advanced Technology Labs., Schenectady, N.Y.
DESIGN CRITERIA FOR ZERO-LEAKAGE CONNECTORS FOR LAUNCH VEHICLES, VOL. 3-SEALING ACTION AT THE SEAL INTERFACE Final Report, Mar. 1962-Feb. 1963
Forrest O. Rathbun, Jr., ed. Mar. 15, 1963 147 p refs
(NASA Contract NAS8-4012)
(NASA CR-50559) OTS: $11.00 ph, $4.61 mf

Consideration has been given to the problem of leakage through passages at the interface of a gasket-sealing surface system. Both analytically and experimentally, predictions have been made relating leakage rates to strength properties of the connector materials, sealing stresses, and surface finishes employed. Experiments have been performed measuring leaks down to 10^{-8} cc/sec through several connector systems. The results of these experiments have been analyzed, and compared with analytic predictions. Author

18 MATERIALS, METALLIC

Includes: cermets; mechanical and physical properties of alloys and metals; and metallurgy.

For related information see: 07 Chemistry; 17 Machine Elements and Processes; 19 Materials, Non-metallic; 33 Stresses and Loads; and 34 Structural Design.

N63-17556 Canadian Westinghouse Co., Ltd. Research and Development Labs., Hamilton

ANNUAL REPORT ON BERYLLIUM RESEARCH 1962

C. Steel and G. S. Armitage Mar. 1963 68 p 13 refs

(CW-R&DL-31; AECL-1715) Available from Scientific Document Distribution Office, Atomic Energy of Canada, Ltd., Chalk River, Ontario, Canada: $1.50

The high temperature mechanical properties have been evaluated for two grades of warm extruded beryllium rod. Both show an improvement over hot extruded material in ductility and consistency of properties at elevated temperatures, with little or no loss in strength. By suitable heat treatment, ductility at elevated temperatures may be improved with little adverse effect on strength. No method has been found to increase room-temperature ductility. Mechanical tests on two analyses of rod, having a nearly random orientation, have shown the effect played by extrusion on rod. While the yield stress is not altered, ductility is very low even with optimum heat treatment. The material does, however, show remarkably consistent results. Tube evaluation has been confined to warm extruded Brush and hot extruded ICI (AGR type). Longitudinal tensile tests were made on Brush tubes with pressure welded end plugs in order to test the efficiency of the welding technique and to give a correlation of data between rod and tube mechanical properties. Burst tests, using warm extruded tubing at elevated temperatures, initially gave scattered results, but much of this was attributable to tube defects and unsuitable welding technique. Improvements in the weld gave results of greater consistency. Hot extruded ICI tube, while only showing a small degree of scatter, gave ultimate hoop stresses lower than those for warm extruded Brush tubing. Author

N63-17561 European Atomic Energy Community, Brussels (Belgium)

IMPROVEMENTS IN SAP TECHNOLOGY WITH A VIEW TO NUCLEAR APPLICATIONS-PROPERTIES OF THE MATERIALS STUDIED [AMÉLIORATIONS DE LA TECHNOLOGIE DU SAP EN VUE DES APPLICATIONS NUCLÉAIRES-PROPRIEÉTÉS DES MATÉRIAUX ÉTUDIÉS]

P. Gualandi (ISML) and P. Jehenson Apr. 1963 29 p 11 refs

In FRENCH; English Summary Presented at the Journées Métallurgiques d'Automne, Paris, Oct. 15–19, 1962

(Contracts EURATOM 003-60-ORG-I; EURATOM 026-61-7-ORG-I)

(EUR-272.f) Available from Belgian American Bank and Trust Co., N.Y. Account No. 121.86: 50 Belg. Fr.

This experimental work represents the initial stage of a long range research program on SAP, in the field of the ORGEL project. The SAP powders used in this research are commercial powders produced by the Swiss Company A.I.A.G.; this company owns the SAP patents. The grades are: SAP 960, at about 4% Al_2O_3; SAP 930, at about 7% Al_2O_3; SAP 895, at about 10 to 11% Al_2O_3; and SAP 865, at about 13 to 14% Al_2O_3. The principal improvement on the semifinished products was obtained by a degassing thermal treatment under vacuum (about twenty hours at 600° to 625° C, under 10^{-4} to 10^{-5} mm Hg) of the powders after cold compaction. The main consequences of this special treatment on SAP, then named SAP-ISML, are the following ones: (1) an important decrease of the residual gas content, which becomes lower than 10 ppm; (2) consequently, an excellent high temperature (600° C) stability and a considerable improvement of the welding properties. Author

N63-17562 Bureau of Mines. Reno Metallurgy Research Center, Nev.

EFFECT OF IMPURITIES ON MECHANICAL PROPERTIES OF ELECTROLYTIC TITANIUM

J. D. Ramsdell and D. R. Mathews 1960 16 p 11 refs

(BM-RI-5701)

The purpose of this investigation was to determine the effects of the impurities, oxygen, nitrogen, carbon, and iron (in low percentages), on the mechanical properties of electrolytic titanium. The strength and hardness of binary Ti-O, Ti-N, and Ti-C alloys are linear functions of alloy content in the composition range investigated. Compared to oxygen and carbon, nitrogen is the most effective strengthener and hardener, followed by oxygen, then carbon. When the carbon concentration is above 0.10 percent, carbides are present, and strength and hardness are relatively unchanged. For equivalent hardness levels, Ti-Fe alloys are stronger than binary titanium alloys containing oxygen, nitrogen, or carbon. However, the strengthening is related to the presence of transformed beta in the structure. Author

N63-17569 California U., Livermore. Lawrence Radiation Lab.

SOME PHYSICAL, MECHANICAL, AND THERMODYNAMIC PROPERTIES OF TRANSITION METAL REFRACTORY CARBIDES: A BIBLIOGRAPHY

Jean E. Senkin and M. Temple Milliken, comps. Mar. 1963 196 p 1072 refs

(Contract W-7405-eng-48)

(UCRL-7284) OTS: $2.75

This bibliography is a collection of references on the subject of properties of refractory carbides. Emphasis is placed upon references concerning the mechanical, physical, and thermodynamic properties of the carbides of Ti, V, Cr, Mo, and W. Also included are the carbides of Hf, Ta, Zr, and Nb. Author

N63-17581 Aeroprojects, Inc., West Chester, Pa.

INVESTIGATION OF ULTRASONIC WELDING OF REFRACTORY METALS AND ALLOYS Bimonthly Progress Report No. 4, Feb. 16, 1963–Apr. 15, 1963

May 1963 16 p refs

(Contract NOw-63-0125-C)

A laboratory-type 4-kilowatt spot-welding machine was instrumented for power-force programing. Preliminary investigations using this improved technique were carried out in the welding of 2024-T3 bare aluminum, AISI 304 stainless steel, and Inconel X alloys. Author

N63-17587 Defense Metals Information Center, Battelle Memorial Inst., Columbus, Ohio

STRUCTURAL CONSIDERATIONS IN DEVELOPING REFRACTORY METAL ALLOYS

R. I. Jaffee and G. T. Hahn Jan. 31, 1963 33 p 46 refs
(Contract AF 33(616)-7747)
(DMIC-182)

Progress made in applying advanced techniques and structural concepts to the problem of strengthening the Group VI-A metals, Cr, Mo, and W, is examined. At low temperatures, T/T_m 0.2, dislocations, and grain boundaries play an important role. High strength values and the marked temperature and strain-rate dependence of the yield stress exhibited by the Group VI-A metals in this range are consistent with the idea that dislocation movement is rate controlling and thermally activated. At intermediate temperatures, $0.2 < T/T_m < 0.4$, dislocation-interstitial atom impurity interactions contribute to strengthening. A number of mechanisms are possible, and these may have practical implications. At high temperatures, T/T_m 0.4, stable dispersions of fine particles are potent strengtheners of the Group VI-A. Small nonmetallic additions, i.e., dope, acting in solution or possibly at the grain boundaries may also contribute to the stability of nonsag tungsten filaments. Author

N63-17621 Bureau of Mines. Salt Lake City Metallurgy Research Center, Utah

AN INTRODUCTION TO STATISTICAL DESIGN OF EXPERIMENTS IN METALLURGICAL RESEARCH

S. J. Hussey, P. L. Placek, and C. H. Schack 1963 115 p 26 refs
(BM-RI-6232)

Studies are reported on the application of statistical methods to planning and evaluating research in extractive metallurgy. The purpose of statistical design is to plan experiments so that the results will yield meaningful information about fundamental or empirical relationships. The designs discussed are for (1) estimating the effect of one or more independent variables upon a dependent variable and (2) defining the equation by which the dependent variable can be estimated from values of the independent variables. Areas covered are: (1) design of experiments, (2) nested designs, and (3) the importance of experimental error in design considerations. N.E.A.

N63-17658 Hughes Research Labs., Malibu, Calif.

A COMPARISON OF THE CONTACT IONIZATION OF CESIUM ON TUNGSTEN WITH THAT OF MOLYBDENUM, TANTALUM, AND RHENIUM SURFACES

O. K. Husmann N.Y., American Inst. of Aeron. and Astronautics, Mar. 1963 28 p 26 refs Presented at the AIAA Electric Propulsion Conf., Colorado Springs, Mar. 11-13, 1963
(NASA Contract NAS5-517)
(AIAA Paper 63019) AIAA: $0.50 members, $1.00 nonmembers

Surface ionization of cesium on porous tungsten, rhenium, molybdenum, and tantalum is reported in light of the ionization efficiency and the critical emitter temperature up to current densities of 10 mA/cm^2. (The experimental method described previously is used.) Results from the porous materials are compared with solid surface data. The neutral detector characteristics are discussed. Comparison of porous tungsten, rhenium, molybdenum, and tantalum up to ion current densities of 10 mA/cm^2 indicates the superiority of tungsten with respect to the critical temperature and the related power efficiency. Power efficiencies for clean and oxygenated porous tungsten are computed taking into consideration beam power and radiation losses. By introducing oxygen into the ultra-high vacuum system, the ionization efficiency can be increased. If carbon is present on the heated parts, it can be detected as CO_2 and CO; the time of desorption of oxygen from the emitter surface is short in comparison with the time of engine operation. Monitoring five different porous tungsten pellets at their critical temperatures for 10 mA/cm^2 cesium ion current density, for over 10 months, allows preliminary extrapolation of life expectancy. Author

N63-17667 Directorate of Materials and Processes. Aeronautical Systems Div., Wright-Patterson AFB, Ohio

WEATHER EXPOSURE DATA FOR HIGH TEMPERATURE COATINGS ON CHROMIUM HOT-WORK TOOL STEELS [Final] Report [Jan. 1957-Apr. 1962]

G. W. Lawless Nov. 1962 17 p 2 refs
(ASD-TDR-62-888)

Results are reported of a 4 1/2-yr. continuous exposure of coated Thermold J steel (SAE H-11) at Kure Beach, North Carolina. Eleven coatings were tested in various modifications, thicknesses, and pre-exposure thermal treatments. A nickel-zinc coating provided the best protection from corrosion during this type of exposure. A summary is included of the oxidation, mechanical, and short-term corrosion tests conducted on these same coatings by Metcut Research Associates in 1957, during which investigation of the coated steel, specimens were exposed at Kure Beach. Author

N63-17672 Pratt and Whitney Aircraft, Middletown, Conn.

WORK HARDENING MECHANISM IN BODY-CENTERED-CUBIC METALS [Final] Report [Feb. 1, 1962-Nov. 31, 1962]

Donald P. Gregory Wright-Patterson AFB, Ohio, Directorate of Mater. and Processes, Mar. 1963 55 p 22 refs
(Contract AF 33(616)-7855)
(ASD-TDR-62-354, Pt. II)

This report presents results of a continued study of work-hardening mechanisms in niobium and tungsten at low temperatures, preliminary studies of their alloys at elevated temperatures, and a literature survey of the deformation of body-centered-cubic metals. Author

N63-17689 Brush Beryllium Co., Cleveland, Ohio

INVESTIGATION OF INTERMETALLIC COMPOUNDS FOR VERY HIGH TEMPERATURE APPLICATIONS [Interim Report, 1 Nov. 1960-31 Dec. 1961]

Johnathan Booker, Robert M. Paine and A. James Stonehouse Wright-Patterson AFB, Ohio, Directorate of Mater. and Processes July 1962 90 p 21 refs
(Contract AF 33(616)-6540)
(WADD-TR-60-889, Pt. II)

Three different areas were studied in a continuing investigation of intermetallic beryllides and silicides for very high temperature applications. The measured properties of Ta_2Be_{17} were unaffected by minor variations in stoichiometry between 800° and 3000° F, whereas best results for WSi_2 were obtained with a material slightly deficient in tungsten. However, WSi_2 exhibited poorest oxidation resistance at 2200° F. Results are reported for oxidation-rate studies on $TaBe_{12}$, Ta_2Be_{17}, $ZrBe_{13}$, and Zr_2Be_{17} in the temperature range from 2300° to 2750° F. The vapor pressures for these same compounds were measured between 2300° and 2650° F, using the Knudsen cell technique. For $TaBe_{12}$, the activation energy for oxidation is lower than the vaporization energy in this temperature range. The oxidation products of Zr_2Be_{17} were found to be $ZrBe_5$ and BeO. Author

N63-17695 Atomics International, Canoga Park, Calif.

CARBURIZATION OF AUSTENITIC STAINLESS STEEL BY URANIUM CARBIDES IN SODIUM SYSTEMS

B. A. Webb May 31, 1963 35 p 5 refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-6246) OTS: $0.75

The stability of uranium carbides in sodium-bonded stainless steel cladding has been studied in long-term compatibility tests at 1000°, 1200°, and 1600° F, out of pile. No apparent carburization of the cladding occurs when the carbon content of the U-C is 4.8 wt % or below. Extensive carburization of Type 304 and Type 347 stainless steels occurs at 1000° F and above, when the carbon content of the U-C exceeds 4.8 wt %. The dispersed UC_2 phase in hyperstoichiometric uranium carbide is the carbon source. The degree of cladding carburization increases with the carbon content of the U-C composition. From the results of these experiments, it is calculated that stainless steel cladding (0.010 in. wall thickness) with sodium-bonded, 0.500-in.-diameter U – 4.9 wt % C fuel could be carburized to an average carbon content of 0.5 to ~2.0 wt % in three years of reactor operation at a 1000° F fuel surface temperature. At a 1200° F surface temperature, the carbon level in the cladding could range from ~1.2 to ~2.0 wt %. As the fuel diameter increases, the upper carburization limit increases, since the ratio of fuel volume to cladding volume increases. Therefore, 0.800-in.-diameter U – 4.9 wt % C fuel could carburize the cladding to a maximum 3% level. Author

N63-17707 Electro-Optical Systems, Inc., Pasadena, Calif.

COMPARISON OF COMMERCIAL, SPHERICAL POWDER AND WIRE BUNDLE TUNGSTEN IONIZERS

G. Kuskevics and B. L. Thompson N.Y., AIAA [1963] 45 p 15 refs Presented at the AIAA Electric Propulsion Conf., Colorado Springs, Mar. 11–13, 1963
(NASA Contracts NAS8-2547 and NAS8-1537; AF 33(616)-6958)

Cesium ionization on different porous tungsten structures was measured in terms of neutral fraction, critical temperature, and flow rate in a regular laboratory-test-chamber environment in the 10^{-6} torr range. These structures included 3/16-inch commercial sintered ionizers with about 2-micron average pore diameter, spherical powder ionizers of 6-micron effective pore diameter, and 12- and 6-micron-diameter wire-bundle ionizers. Ion current and neutral fraction were plotted as log j or log α versus 1/T, which allowed easier selection of the critical temperatures. The directly heated ionizers could be operated up to 1500° C. The best critical temperatures for all tungsten ionizers in the 10^{-6} torr residual gas pressure at current densities between 1 and 20 ma/cm^2 were within 100° K of Langmuir's data for solid tungsten. Since the surface was not clean, the critical temperature had a considerable spread. Neutral fractions for commercial sintered, spherical powder and fine wire-bundle ionizers ranged from 0.1 to 5 percent, but were considerably higher for coarse wire-bundle ionizers. Author

N63-17740 Atomics International, Canoga Park, Calif.

THERMAL PROPERTIES OF REFRACTORY MATERIALS

Third Quarterly Progress Report

R. E. Taylor and M. M. Nakata May 1963 22 p 9 refs
(Contract AF 33(657)-7136; ARPA Order 24-62)

The current status of the development of the transient thermal-property apparatus is described. The upper temperature limit of the apparatus has been extended several hundred degrees, and it appears feasible to obtain accurate data up to at least 2500° C. Progress has also been made in extending the temperature range downward from the 1200° C minimum imposed by the photomultiplier tube detector. The status of thermal-property measurements by existing techniques is also included. Additional thermal-conductivity data are presented, and the inability of contemporary theory to explain heat conduction in the refractory interstitial compounds is proved. Author

N63-17746 Illinois U., Urbana

EFFECTS OF REPEATED LOADING AND MOISTURE ON THE FRACTURE TOUGHNESS OF S. A. E. 4340 STEEL

William Alan Van Der Sluys May 1963 44 p 13 refs
(Contract Nonr-2947(01)(X))
(T&AM-245)

This investigation determined the combined effect of water vapor and repeated loading on slow crack growth and fracture toughness. Round notched bars of SAE 4340 steel with a Rockwell C hardness of 48 were tested in tension, in a controlled environment, and at room temperature. The compliance of the specimen was measured on each cycle and was used to determine the amount of crack growth. It appears that the G_{Ic} values (fracture toughness) may be lowered slightly as the moisture content of the atmosphere increases. It was also found that water vapor alone assists slow crack growth but that water vapor combined with repeated loading has a greater effect. The effect can be easily seen by looking at the ratio $\left(\frac{\sigma'_n}{\sigma_{yp}}\right)$ where σ'_n is the stress level sufficient to cause either slow crack growth or failure in less than 100 cycles. The amazing result is that if a specimen was cycled in the 100% relative humidity condition and with a natural crack present, the $\left(\frac{\sigma'_n}{\sigma_{yp}}\right)$ ratio was found to be about 0.30 whereas it was about 0.55 if no moisture was present. Author

N63-17747 Universal-Cyclops Steel Corp. Refractomet Div., Bridgeville, Pa.

MOLYBDENUM SHEET ROLLING PROGRAM Interim Report, Jan. 26, 1963–Apr. 25, 1963

Apr. 25, 1963 19 p
(Contract NOA(s)-59-6142-C)
(Rept.-20)

Forging billets have been prepared for production of .020 inch Mo+0.5%Ti sheet. Phase II TZM .060 inch and .020 inch have been completely evaluated. Melting and extrusion of this material is partially completed. Author

N63-17810 Atomic Energy of Canada Ltd., Chalk River

RESEARCH ON THE CORROSION OF ZIRCONIUM ALLOYS IN WATER AND STEAM AT HIGH TEMPERATURE AND PRESSURE

A. A. Kiselev, V. A. Myshkin, A. V. Kozhevnikov, S. I. Korolev, and E. G. Shorina Apr. 1963 38 p 10 refs Transl. from the Proc. of the IAEA Conf. on Corrosion of Reactor Materials, Salzburg, Austria, Vol. II, June 4–8, 1962 p 67–104
(AECL-1724) Available from Scientific Document Distribution Office, AEC of Canada Ltd., Chalk River, Ontario, $1.00

This paper presents the corrosion kinetics for zirconium-niobium alloys used in reactor construction. The data were obtained by tests in high-pressure, high-temperature water or steam in static autoclaves, over periods of 14,000 to 22,000 hours. The Zr 1 wt% Nb alloy corrodes rapidly at first, but the rate soon decreases. In water at 350° C, a parabolic rate law is obeyed from 500 to 22,000 hours: $\log \Delta m = 0.2 + 0.5 \log t$ where Δm is the weight increase in mg/dm^2 and t the time in hours. Deviations from the mean value are primarily a function of the surface treatment. Data are presented on the mechanical properties of various alloys as a function of corrosion testing for periods up to 18,000 hours. The pickup of hydrogen and the manner in which this affects the mechanical properties is discussed. Rate equations are also given for the corrosion kinetics of "Ozhennite 0.5" and Zr 2.5 wt% Nb. The long-term corrosion behavior of zirconium with 0.25 to 1.5 wt% niobium and with iron, nickel, and tin has been investigated. The corrosion resistance of zirconium is very inconsistent; however, by addition of 0.25 to 1.5 wt% niobium or small quantities of iron a consistent product is achieved, the corrosion resistance of which is similar to that of the best pure zirconium. These alloying additions result in a decrease in hydrogen pickup; nickel also improves the corrosion resistance, but enhances the rate of hydrogen pickup. Author

N63-17882 Battelle Memorial Inst., Columbus, Ohio
INVESTIGATION OF TANTALUM AND ITS ALLOYS [Final Report, Apr. 1, 1962-Feb. 28, 1963]
Frank F. Schmidt, Edwin S. Bartlett, and Horace R. Ogden Wright-Patterson AFB, Ohio, AF Materials Lab., May 1963 139 p 14 refs
(Contract AF 33(657)-7927)
(ASD-TDR-62-594, Pt. II)

Minor (1 to 2 percent) reactive metal (Zr, Hf) additions to Ta-W-Mo alloys effect pronounced strengthening at 1925° C (3500° F) with minimal degradation of low-temperature alloy behavior. Additions of carbon to alloys containing reactive metals degrade both 1925° C (3500° F) strength and low-temperature behavior; however, "ZrC dispersions" exhibit pronounced strengthening at lower temperatures [1480° C (2700° F)]. Solution-process anneals for alloys containing "ZrC dispersion" greatly increase strength at 1480° C (2700° F), but seriously impair fabricability and ductility. Molybdenum is a less effective strengthener than tungsten as an alloying addition to tantalum. Tungsten additions provide higher stress-rupture strengths with less degrading effects on low-temperature ductility than do equivalent atomic percentages of molybdenum. Welding increases the ductile-to-brittle transition temperature of Ta-W-Mo alloys by 300° to 500° C (540° to 900° F). Rhenium and ruthenium additions showed little or no superiority to tungsten as solid-solution strengtheners, when both high- and low-temperature effects were considered. Author

N63-17888 Bureau of Mines, Washington, D.C.
FLUORESCENT X-RAY SPECTROGRAPHY: DETERMINATION OF TRACE ELEMENTS
William J. Campbell and John W. Thatcher 1962 34 p 60 refs
(BM-RI-5966)

The purpose of this investigation was to extend the analytical services which are required for Bureau of Mines programs in developing and evaluating high-purity materials. Determination of trace elements in minerals and ores as an aid in geochemical evaluation and prospecting was considered. Results of fluorescent X-ray spectrography indicate that: (1) limits of detectability for trace elements in metal, oxide, solution, or mineral samples range from 0.1 p.p.m. to 100 p.p.m., depending on the element being determined, overall sample composition, and the complexity of the X-ray spectra; and (2) limits of detectability range from 0.01 microgram to 1.0 microgram for elements that have been preconcentrated by a chemical or physical process, e.g., by ion-exchange membrane. I.v.L.

N63-17894 ManLabs., Inc., Cambridge, Mass.
RESEARCH AND DEVELOPMENT ON HIGH-PRESSURE-HIGH TEMPERATURE METALLURGY [Interim Report, Mar. 8, 1962-Dec. 8, 1962]
S. A. Kulin et al Wright-Patterson AFB, Ohio, AF Materials Lab., May 1963 20 p
(Contract AF 33(616)-6837)
(WADD-TR-60-893, Pt. III)

Two separate high-pressure systems have been designed, constructed, and tested. Their successful use to pressures of 60 kilobars and temperatures up to 1500° C has been demonstrated. It is anticipated that both of these systems will be utilized for high-pressure heat treatment of large specimens in the current high-pressure program. Author

N63-17896 Stanford Research Inst., Menlo Park, Calif.
THERMOELECTRIC MATERIALS Summary Report, 1 Jan. 1962-8 Apr. 1963
J. W. Johnson May 15, 1963 17 p
(Contract NObs-77017)

Liquid thermoelectric materials for possible applications to power generation are investigated. The study is confined to variations of thermoelectric parameters of liquid inorganic sulfides and tellurides. Investigations were carried out on the following systems: (1) cuprous sulfide-cuprous telluride, (2) cuprous sulfide-bismuth sulfide, (3) curpous sulfide-nickel sulfide, and (4) cuprous telluride-lead telluride. Of the systems investigated, the cuprous sulfide-cuprous telluride system appears to offer promise as the p-type leg of a liquid thermoelectric power generator. N.E.A.

N63-17900 Carnegie Inst. of Tech., Pittsburgh, Pa.
SOME MECHANICAL PROPERTIES OF AUSTENITIC STAINLESS STEEL SINGLE CRYSTALS
G. Meyrick and H. W. Paxton May 27, 1963 32 p 20 refs
(Contract Nonr-760(14))

Observations on the tensile deformation of single crystals of austenitic stainless steels as a function of composition, orientation, and temperature are described and compared with relevant data for other alloys. Crystals free from second phases show sharp yield points followed by Lüders' extensions of up to 20%. The critical resolved shear stress is strongly temperature dependent, increasing fourfold between 423° K and 77° K. A temperature-independent low rate of hardening follows the Lüders' extension, and is frequently associated with overshoot. Unlike pure metals where profuse cross-slip usually occurs at the end of linear hardening, this stage is terminated either by cross-slip or by slip on the conjugate system; the particular node apparently depending upon initial orientation and composition. The presence of δ-ferrite or martensite has a profound effect upon the magnitude of the yield stress and the shape of the stress-strain curve. Author

N63-17914 Argonne National Lab., Ill.
EFFECTS OF IRRADIATION ON THORIUM AND THORIUM-URANIUM ALLOYS Final Report
J. H. Kittel, J. A. Horak, W. F. Murphy, and S. H. Paine Apr. 1963 38 p 16 refs
(Contract W-31-109-eng-38)
(ANL-5674)

Three separate irradiation experiments have been completed with thorium and thorium-uranium alloys. In the first experiment, three rolled plates of thorium and Th-5 w/o U alloy, irradiated to total atom burnups up to 1.5 percent at 200° C, showed no anisotropic growth, and decreased in density at a rate of 1% per a/o burnup. In the second experiment, 15 swaged specimens of thorium and of the alloys Th-0.1 w/o U, Th-1.4 w/o U; and Th-5.5 w/o U were irradiated to burnups ranging from 0.3 to 3.6 percent of all atoms, at temperatures in the range of 45° to 200° C. Again, no anisotropic growth was observed, and densities decreased at rates near 1% per a/o burnup. A Th-1.4 w/o U alloy specimen with 2.0 a/o burnup was found to have retained significant room-temperature ductility. In the final experiment, a group of 44 chill-cast specimens of thorium alloys containing 10, 15, 20, 25, and 31 w/o uranium were irradiated to burnups ranging from 0.16 to

10.1 percent of all atoms. Maximum irradiation temperatures ranged from 260° to over 1000° C. Surface roughening occurred in the alloys containing 25 and 31 w/o uranium. Volume increases at any given temperature for all alloys were linear with increasing burnup. The rate of volume increase for all alloys rose from approximately 1% per a/o burnup at the lower temperatures, to a value of 2.5 at 650° C. Thereafter, the swelling rate increased somewhat, reaching a value of 6% volume increase per a/o burnup at 800° C. The rates of volume increase under irradiation of thorium–uranium alloys in the entire temperature range studied were significantly less than those reported for the best uranium-base alloys. Author

N63-17930 Rock Island Arsenal Lab., Ill.
EFFECT OF METAL HARDNESS AND SURFACE FINISH UPON FRETTING CORROSION Technical Report
S. Fred Calhoun May 28, 1963 11 p 14 refs
(RIA-63-1835) OTS: $0.50

The fretting damage to each of two different surface finishes on each of two degrees of hardness of test specimens of the same carbon steel was determined. Five greases of nearly identical composition and physical characteristics were used, thus conceivably nullifying any effect due to these grease properties. If the hardness of the specimens was the same, the smoother finish suffered the most fretting damage in all but one case. When the effects of surface finish were considered, it was observed that for the smoother finish the harder material fretted more, but for the coarser finish the softer material was affected most. Author

N63-17956 Watertown Arsenal Labs., Mass.
AUSTENITIC DECOMPOSITION IN WELDING STEEL Technical Report
Mark M. D'Andrea, Jr. Mar. 1963 36 p 12 refs
(WAL-TR-320.1/12) OTS: $1.00

A time-temperature controller was used in conjunction with a dilatometer to study the transformational behavior of weld heat-affected zone austenite upon cooling from a 1700° F peak temperature. The austenite was typified by prior base-metal history (defined by heat treatment and hardness), by a rapid heating situation, and by a transient time at the 1700° F peak temperature before cooling. Continuous-cooling transformation diagrams were made in this way of AISI 4340 steel, initially quenched-and-tempered to two different hardness levels, 54 and 44 R_c, respectively. The two continuous-cooling transformation diagrams were the same, indicating no significant difference in the austenites produced from the 54 and 44 R_c structures. For the majority of the cooling conditions investigated, the martensite-start (M_s) temperature was found to be 522° F. The M_s temperatures associated with two of the steepest curvilinear cooling curves used to construct the continuous-cooling diagrams were found to be as much as 58° F above 522° F; the shape and position (in time and temperature) of cooling curves in the austenitizing range on cooling from 1700° F appeared to exert a strong influence on the transformational behavior of the austenite produced. Author

N63-17962 Atomics International, Canoga Park, Calif.
THE ELECTRICAL CONDUCTIVITIES OF MOLTEN BISMUTH-BISMUTH TRIIODIDE SOLUTIONS
L. F. Grantham and S. J. Yosim June 26, 1963 19 p 25 refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-8086)

The electrical conductivities of Bi-BiI_3 solutions were measured above the consulute temperature over the entire composition range. The specific conductance increases continuously and monotonically with increasing metal composition; for example, at 500° C the increase is from 0.32 for pure BiI_3 to 7.170 (ohm-cm)$^{-1}$ for the metal. The temperature coefficients of the specific conductance are positive for all compositions except those greater than 80 mole percent bismuth. Both a positive and negative temperature coefficient were observed at 80%. The results are discussed in terms of various mechanisms of conductance. Author

N63-17975 Wien U. Physikalisches Inst. (Austria)
INVESTIGATION OF THE EFFECTS OF ULTRASONICS ON THE DEFORMATION CHARACTERISTICS OF METALS Interim Report No. 1, Feb. 1-Apr. 30, 1963
1963 8 p 11 refs
(Contract N-62558-3436)

A few aspects of the ultrasonic influence on the plasticity of metals are treated. It is shown that with purest zinc crystals, the recovery from the cold-hardened condition (measured as the decrease of the shearing stress of the basal plane) is accelerated by an ultrasonic treatment during the period of recovery. Also, the second softening mechanism—recrystallization by way of nucleation and growth of crystals—is activated at certain temperatures by ultrasonic influence, as is shown by tests with polycrystalline specimens of commercial zinc. Both softening mechanisms are based on diffusion processes in the lattice, whose kinetics is accelerated by ultrasonic treatment under the conditions used. Author

N63-18002 Lockheed Missiles and Space Co., Sunnyvale, Calif.
THERMODYNAMIC PROPERTIES OF MOLYBDENUM AND COLUMBIUM: AN ANNOTATED BIBLIOGRAPHY [Period Covered, 1924–1962]
Jack B. Goldmann, comp. June 1963 80 p 184 refs
(SB-62-69; Rept. 6-90-122)

The data which are included encompass heat of formation, activity, entrophy, diffusion rates and diffusion constants. In addition, references to the research which has been done, and the tests and instrumentation are noted. The period covered by this bibliography is 1924–1962, with special emphasis on the literature published since 1955. Author

N63-18013 Atomic Energy Commission. Div. of Technical Information, Washington, D.C.
DIFFUSION OF METALS: EXCHANGE REACTIONS
Wolfgang Seith and Theodor Heumann Jan. 1962 291 p 18 refs Transl. by JPRS of "Diffusion in Metallen: Platzwechselreaktionen" Berlin, Springer-Verlag, 1955
(AEC-TR-4506) OTS: $3.50

This review includes: (1) the definition of the diffusion coefficient and Fick's equations; (2) methods of diffusion investigations covering metallographic, chemical, and physical methods, as well as measurements with radioactive tracers; (3) general laws and theories of exchange reaction phenomena, and of exchange reaction mechanisms and temperature dependence; (4) concentration dependence of the diffusion coefficient covering the Mantano evaluation and the calculation of diffusion processes with concentration-dependent diffusion coefficients; (5) the determination of diffusion coefficients in the case of volume variation; (6) the relationship between the coefficients of self-diffusion and heterogeneous diffusion in binary solid solutions; (7) partial diffusion coefficients covering the Kirkendall effect and Darkens formulas, the effect of unequal diffusion of components, and particle flow of diffusion components and hole concentration; (8) a multiphase constitution diagram and the diffusion process including diffusion in several phases, and examples for calculating the diffusion in a multiphase system; (9) the directional dependence of diffusion in the crystal lattice; (10) surface diffusion and intergranular diffusion; (11) propagation diffusion; (12) the influence of third alloy components on diffusion; (13) the segregation theory; (14) various exchange reaction phenomena; (15) sintering; (16) the electrolytic transfer in alloys; (17) diffusion in liquid alloys; (18) the diffusion of gases in metals. I.v.L.

N63-18016 Defense Metals Information Center, Battelle Memorial Inst., Columbus, Ohio

REVIEW OF RECENT DEVELOPMENTS—MOLYBDENUM AND MOLYBDENUM-BASE ALLOYS **Covers Period Mar. 11-June 10, 1963**

J. A. Houck June 28, 1963 2 p 5 refs

A brief review of new developments in the metallurgy of molybdenum and its alloys is given, covering: the completion of the rolling and evaluation of TZM alloy sheet bars, whose best properties are obtained in moldout (0.125-in.-thick sheet that was rolled at either 2400° or 2800° F; the effect of vacuum-purity levels on the fabricability and properties of TZM alloy sheet when rolled in a vacuum processing facility —the sheets can be fabricated at 100 microns pressure to 2000° F without contamination; the development of a "chem-blanking" technique to avoid delaminations of edges when sawing and shearing molybdenum alloys; a comparison of the mechanical properties of arc-cast and pressed-and-sintered unalloyed molybdenum forgings, which showed that the arc-cast is the stronger of the two materials at 1500° F, but weaker from 1500° to 4300° F; and the production of defective ingots by arc-melting of TZC alloy. D.E.R.

N63-18028 North Carolina State Coll., Raleigh

RESEARCH ON GROWTH AND DEFORMATION MECHANISMS IN SINGLE CRYSTAL SPINEL **[Final Report, Feb. 1961-July 1962]**

Hayne Palmour, III, W. Wurth Kriegel, and R. Douglas Mc Brayer Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Feb. 1963 81 p refs
(Contract AF 33(616)-7820)
(ASD-TDR-62-1086)

The first phases of a continuing program of research on growth and deformation processes in magnesium aluminate spinel are described. Spinel forming reactions, structure and properties of spinel, synthesis of spinel feed materials (including a study of the effects of irradiation on spinel formation), techniques and apparatus for crystal growth with Verneuil oxy-hydrogen and RF plasma devices, and the effect of atmosphere on precipitation hardening of alumina-rich spinel have been studied. The report includes a summary of structural and physical properties of $MgAl_2O_4$ spinel. Author

N63-18043 National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

AN INVESTIGATION OF THE EFFECT OF TARGET TEMPERATURE ON PROJECTILE PENETRATION AND CRATERING

William H. Kinard and C. H. Lambert, Jr. Washington, NACA, July 28, 1958 19 p 4 refs
(NACA RM L58E14) OTS: $1.60 ph, $0.80 mf (Declassified)

Results of steel projectiles fired into copper targets at velocities from 5,000 to 11,500 feet per second indicate that as the target temperature is increased, the crater size also increases. Projectiles impacting targets heated to 900° F produced craters having as much as twice the volume of craters produced by projectiles of the same type impacting targets having a temperature of 80° F. It appears that the decreasing of the speed of sound in the target material as it is heated can be used as a parameter to predict the amount of increased cratering to be expected when targets are heated. Author

N63-18058 Oregon Metallurgical Corp., Albany

EVALUATION OF MOLYBDENUM METAL PRODUCED BY THE TIN REDUCTION OF MOLYBDENUM DISULPHIDE **Final Report**

Charles Krey, H. Gordon Poole, and Stephen M. Shelton Apr. 13, 1963 98 p
(CONTRACTS NORd-18124 and NOw-62-0754-C)

Low-carbon, low-oxygen molybdenum metal was produced from molybdenum disulfide by reduction with tin. Thermodynamic considerations behind this process are discussed along with theoretical processing advantages. In addition, the possible enhancement of physical properties of molybdenum due to lowering institial impurities (primarily carbon and oxygen) is discussed. Molybdenum produced by the tin reduction of molybdenum disulfide in a pure hydrogen or inert atmosphere has a lower level of interstitials than commercially available molybdenum produced by the hydrogen reduction of molybdenum oxide. This metal was found to be superior chemically to commercial molybdenum and could be fabricated easily by hammer forging and rolling in the as-cast condition from ingot material. C.L.W.

N63-18078 Boeing Co. Transport Div., Renton, Wash.

STRESS CORROSION TESTING OF HIGH STRENGTH STEELS. INVESTIGATION OF SUSCEPTIBILITY OF HIGH STRENGTH MARTENSITIC STEEL ALLOYS TO STRESS CORROSION **Fourth Quarterly Progress Report, Dec. 1, 1961-Mar. 1, 1962**

Gary A. Dreyer Mar. 15, 1962 105 p 3 refs
(Contract AF 33(616)-7839)
(D6-7502-3)

Boeing U-bend specimens were cut from the short transverse grain direction of 4340, 4330M, 4340M, H-11, and AM 350 steel billets. All specimens were heat treated to various strengths, and the surfaces carefully machined. The surfaces of the 4340, 4330M, 4340M, and H-11 steel specimens were ground while the AM 350 specimens were milled. All U-bend specimens (except for six 4340 specimens) which were surface ground were vapor honed following a temper after grinding. The residual surface stresses in representative specimens from all the steels were determined using an X-ray back reflection technique. Tensile data have been obtained from tensile specimens which have received the same heat treatment as the U-bend specimens. In addition, tensile specimens of AM 350 steel (SCT 1050 condition) were tested after tempering for various times at 1050° F. An analysis of a U-bend specimen with a bolt through the center hole is included. Author

N63-18079 Materials Research Corp., Orangeburg, N.Y.

IMPURITY ATOM-DISLOCATION INTERACTIONS AND SUBSEQUENT EFFECTS ON MECHANICAL PROPERTIES OF REFRACTORY METALS **[Final Report, Nov. 1, 1961-Nov. 31, 1962]**

H. R. Nesor and G. T. Murray Mar. 1963 29 p 14 refs
(Contract AF 33(657)-7687)
(ASD-TDR-63-238)

The interaction between dislocations and impurity atoms in electron-beam refined arc-cast molybdenum single crystals has been studied in the form of strain aging and tensile creep experiments. Data were obtained on the kinetics of the "return of the yield drop" process for molybdenum containing carbon in the temperature range from 475° to 650° C. These data yielded an activation energy of 21,400 cal/mol for the process. A comparison is made of this with other published values. A Mo-1%Ta alloy was also examined, but strain-aging effects were not observed. The tensile creep behavior of molybdenum containing carbon was compared with that for high-purity material.

The presence of carbon greatly increased the creep resistance, whereas a polygonization treatment slightly decreased the creep resistance. The tendency for substructure to coarsen was found to be less in molybdenum containing carbon than in high-purity material. Author

N63-18088 Technische Hochschule München. Inst. für Technische Mechanik (W. Germany)

INVESTIGATION OF THE DISTRIBUTION OF TENSION IN NOTCHED CONSTRUCTION ELEMENT [Final Report]

H. Neuber Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, May 1963 65 p 2 refs
(Contract AF 61(052)-200)
(ASD-TDR-63-361)

The theoretical part of the research work concerns a new treatment of stress and strain concentrations for a special nonlinear deformation law for shear. A relation is obtained by which the real notch stress can be evaluated from the nominal stress and the elastic stress concentration factor. The notch-angle is exactly taken into account. The experimental part contains static and fatigue tests with variously notched specimens. The strain-measurements were performed by electrical strain gages; additional measurements were made by means of the photoelastic stress-coat method. The aim of the static tests was die investigation of the notch-angle influence on the elastic stress concentration factor for tension and bending, the determination of the stress and strain distribution in the elastic and plastic range, respectively, and also the dependence of the stress concentration factor on the nominal stress for the materials used (Steel St.00.12, St.00.21, Aluminum alloy "Velodur"). The result of the fatigue tests was the establishment of Wöhler curves for two different specimen shapes (bars with central holes), and their comparison with the Wöhler curve of the corresponding unnotched specimen. Author

N63-18094 Grumman Aircraft Engineering Corp., Bethpage, N.Y.

FATIGUE STUDIES. EFFECT OF DECARBURIZATION ON THE FATIGUE STRENGTH OF 98BV40 STEEL

R. J. Heitzmann Jan. 1963 8 p
(ADN-02-01-62.1)

The results of an investigation into the effect of forged and decarburized surfaces on the fatigue strength of 98BV40 steel are reported. This investigation was initiated by the failure of the W2F-1 nose landing gear piston forging. Subsize tension fatigue specimens were cut from two failed W2F-1 nose landing gear piston forgings, and fatigue tests were conducted in the Sonntag SF-1-U fatigue machine at a stress ratio of +0.05. The fatigue life of ultra-high-strength steels was found to be markedly reduced by the pressure of an as-forged decarburized surface. A substantial reduction of life occurs in the limited life portion of the curve as well as near the endurance limit. C.L.W.

N63-18108 Defense Metals Information Center, Battelle Memorial Inst., Columbus, Ohio

REVIEW OF RECENT DEVELOPMENTS— EVALUATION OF SPECIAL METAL PROPERTIES

J. E. Campbell June 21, 1962 4 p 9 refs

This review of the mechanical properties of various alloys includes: (1) cryogenic properties, (2) effects of strain rate on mechanical properties, and (3) the results of fatigue and fracture testings of the alloys. I.v.L.

N63-18115 Hanford Atomic Products Operation, Richland, Wash.

EROSION-CORROSION OF ALUMINUM ALLOYS

R. L. Dillon and R. S. Hope Apr. 1963 33 p 9 refs
(Contract AT(45-1)-1350)
(HW-74359, REV) OTS: $0.75

A pattern of attack, qualitatively similar to groove pitting of irradiated fuel cladding, has been produced in the laboratory. The relative susceptibility to attack of X-8001 alloy aluminum in comparison to 1245 alloy aluminum is in agreement with reactor experience. Tests have shown that the laboratory-simulated groove pitting involves both mechanical and chemical components. Under the conditions studied, both must be present before observable metal removal occurs. Of the mechanical factors studied, flow rate of the water was most important. At a given flow rate, temperature, and water quality, increase in pressure on the system tended to reduce the attack. The effect of water chemistry is demonstrated by the inability to simulate groove pitting, or in fact to remove metal, in deionized water; substantial attack can be produced in process waters. The laboratory tests were largely conducted with laboratory tap water rather than reactor process water, both as a matter of availability and as a device for accelerating the corrosion process. Significant inhibition of metal removal resulted from dichromate additions and reduced pH. Author

N63-18133 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN INVESTIGATION OF A NEW NICKEL ALLOY STRENGTHENED BY DISPERSED THORIA

Charles R. Manning, Jr., Dick M. Royster, and David N. Braski Washington, NASA, July 1963 39 p 13 refs
(NASA TN D-1944) OTS: $1.00

An experimental investigation was made to evaluate sheet material composed of a new nickel alloy strengthened by dispersed thoria, for aerospace applications in the temperature range from 1,800° F to 2,400° F. Mechanical-property tests were made at room and at elevated temperatures from 1,700° F to 2,570° F. The effect of preoxidation at various temperatures on the room-temperature tensile properties is also shown. One diffusion coating was evaluated to determine its effectiveness in reducing oxidation. Fabrication studies included machining, diffusion-bond joining, and several different welding processes. A description of the equipment and procedures utilized in performing the evaluation tests is also included. The metallurgical study included X-ray analysis and a microstructural examination of uncoated and coated sheet material. Author

N63-18186 General Electric Co. Research Lab., Schenectady, N.Y.

RESEARCH AND DEVELOPMENT OF THE EFFECTS OF HIGH PRESSURE ON VARIOUS ELEMENTS AND BINARY ALLOYS. PART I: EFFECT OF PRESSURE ON THE AUSTENITE TO PEARLITE REACTION [Interim Report, 1 Apr. 1961-1 Apr. 1962]

J. E. Hilliard Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, May 1963 41 p 14 refs
(Contract AF 33(616)-8206)
(ASD-TDR-62-479, Pt. I)

The growth rate and interlamellar spacing of pearlite have been determined as a function of transformation temperature at one atmosphere and 30 kilobars pressure, in eutectoid iron-carbon alloys containing approximately one percent manganese. The atmospheric-pressure growth rates, measured at four temperatures in the range 560° to 680° C, were in fair agreement with data obtained on a similar alloy by other investigators.

Indications were found of a change in slope of the reciprocal spacing vs. temperature curve at one atmosphere, corresponding to the onset of partitioning of manganese between ferrite and cementite at 640° C. High-pressure runs were made at seven temperatures in the range 400° to 620° C. Author

N63-18190 Bendix Corp. Bendix Products Aerospace Div., South Bend, Ind.

STRENGTHENING OF CHROMIUM-MAGNESIA COMPOSITES Interim Report No. 2, Apr. 1, 1963-May 31, 1963

G. C. Reed June 14, 1963 16 p
(Contract N600(19)59647)

The notch tensile properties of Chrome-30 were previously evaluated at several stress concentration levels. Extrusions were prepared for evaluation of several compositional and processing variables aimed at improving ductility prior to initiation of the alloying study. The impact and tensile properties exhibited by these extrusions have now been determined, and are reported herein. Pertinent chemical analyses are also reported. The best improvements were obtained by reducing the magnesia content. The compound containing three weight-percent magnesia exhibited 45% tensile elongation at room temperature. Author

19 MATERIALS, NONMETALLIC

Includes: mechanical and physical properties of non-metals (e.g., plastics).

For related information see: 07 Chemistry; 17 Machine Elements and Processes; 18 Materials, Metallic; 33 Stresses and Loads; and 34 Structural Design.

N63-17636 Lockheed Missiles and Space Co., Sunnyvale, Calif.

PYROLYTIC GRAPHITE AND RELATED REFRACTORY MATERIALS: AN ANNOTATED BIBLIOGRAPHY [Period Covered, July 1961-June 1962]

Jack B. Goldmann, comp. Sept. 1962 62 p 124 refs
(SB-62-27; Rept. 3-80-62-16)

A survey of printed sources which refer to pyrolytic graphite and related refractory materials was made for the period July 1961 to June 1962. This annotated bibliography includes references to pyrolytic boride, pyrolytic carbide and pyrolytic carbon, as well as pyrographite. Other areas for investigation were tantalum boride; silicon, tantalum, titanium and zirconium carbide; and boron and titanium nitride. Author

N63-17997 DeBell and Richardson, Inc., Hazardville, Conn.

FEASIBILITY STUDY ON HEXAGONAL GLASS FILAMENTS Final Report

William J. Eakins, Richard A. Humphrey, and Daniel Hess June 21, 1963 10 p 5 refs
(Contract Nonr-3885(00) (X))

It was demonstrated that hexagonal filaments can be made from E glass by the preform attenuation technique. A procedure was developed for grinding flats on round rods in order to produce hexagonal preforms. Strength tests on single filaments proved the desirability of acid polishing the ground preforms prior to forming filaments. Photomicrographs of a sample of hexagonal filaments forced together in an imbedding resin show perfect packing. Author

N63-18032 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

SELECTION OF POLYMERIC MATERIALS FOR SPACECRAFT APPLICATION

R. A. Boundy Oct. 15, 1962 20 p 5 refs
(NASA Contract NAS7-100)
(JPL Section Rept. 353-1) OTS: $1.60 ph, $0.80 mf

The selection of polymeric materials for spacecraft application is discussed in three phases. First, an experimental program for evaluating plastics under vacuum-thermal conditions is described and the results discussed. Second, the selection of plastic materials for unmanned spacecrafts is discussed and illustrated by actual component application. These include various antennas, thermal shields, and RF-transparent rod-end bearings. Third, typical problems encountered during type-approval testing are described, and their solutions discussed. These include a gamma-ray spectrometer cable and low-reflectance materials for optical applications. Conclusions are presented for the three phases. Author

N63-18033 General Electric Co. General Engineering Lab., Schenectady, N.Y.

DEVELOPMENT OF LOW TEMPERATURE DIELECTRIC COATINGS FOR ELECTRICAL CONDUCTORS Fifth Quarterly Progress Report

K. N. Mathes Oct. 15, 1962 17 p
(NASA Contract NAS8-2442)
(NASA CR-50338) OTS: $1.60 ph, $0.80 mf

Progress in a program to evaluate wires (with heavy polyvinyl formal enamel, extruded polyvinylchloride, and extruded polytetrafluorethylene as controls) at cryogenic temperatures after thermal aging at 250° C, at 120° C, and at 120° C in vacuum is reported. Electric breakdown data for wire insulators in liquid hydrogen are summarized. The breakdown in liquid hydrogen is comparable with that in liquid nitrogen and generally higher than in liquid helium. D.E.R.

N63-18080 Honeywell Research Center, Hopkins, Minn.

THE TENSILE STRENGTH OF MAGNESIUM OXIDE Sixteenth Technical Report

R. J. Stokes and C. H. Li June 1962 27 p 13 refs
(Contract Nonr-2456(00))

Fully dense magnesium oxide bicrystals and tricrystals have been chemically polished to remove all the "fresh" slip dislocation sources normally present in the surface, and tested in tension. With this surface condition, bicrystals deform elastically up to extremely high stresses (>110,000 psi) before separating from the tensile grips, indicating that the intrinsic intergranular strength is at least this value. Author

N63-18082 National Engineering Science Co., Pasadena, Calif.

DESIGN CONCEPTS FOR MINIMUM WEIGHT, HIGH PERFORMANCE SUPERSONIC AIRCRAFT STRUCTURES: HAZARD PROTECTION RESEARCH Third Quarterly Progress Report [Dec. 1, 1962-Feb. 28, 1963]

H. Landesman, J. E. Basinski, and P. Gayle Keen Mar. 14, 1963 30 p
(Contract AF 33(657)-8937)

Investigations were conducted to find materials suitable for use in the in-flight fire extinguishing system of the supersonic transport. Results indicate that, on the basis of vapor pressure, thermal stability, viscosity, and flammability limit screening thus far, the compound 1-bromo-2,4-dichloro-1,1,2,3,3,4-hexafluorobutane appears to be the most promising material yet examined for producing nonflammable heptane-air-inhibitor mixtures required for the fire extinguishing system under study. I.v.L.

N63-18083 Honeywell Research Center, Hopkins, Minn.
DISLOCATIONS AND THE TENSILE STRENGTH OF POLYCRYSTALLINE MAGNESIUM OXIDE
R. J. Stokes and C. H. Li Jan. 1963 25 p 16 refs
(Contract Nonr-2456(00))
(HR-63-252)
(Tech. Rept. 18; HR-63-252)

The tensile strength of polycrystalline magnesia can be high (approximately 30,000 psi) providing there are no "fresh" or mobile dislocations present. These dislocations may originate in one of two ways. In the first, they may be introduced directly by mechanical contact with the surface. In the second, they may be generated indirectly through the stress concentrations associated with pores. To attain tensile strengths higher than 15,000 psi, it is necessary to use fully dense pore-free material whose surface has been chemically polished, or otherwise protected from mechanical contact. Author

N63-18120 Naval Research Lab., Washington, D.C.
FRICTIONAL PROPERTIES OF POLYETHYLENES AND PERFLUOROCARBON POLYMERS [Interim Report]
R. C. Bowers and W. A. Zisman June 4, 1963 17 p 22 refs
(NRL-5945) OTS: $0.50

Friction was measured at 25° C for steel sliding on polytetrafluoroethylene (TFE), a copolymer of tetrafluoroethylene and hexafluoropropylene (FEP), three high-density polyethylenes (HDP), and two low-density polyethylenes (LDP) at a velocity of 0.01 cm/sec and with a load of 1000 grams. The static coefficient of friction (μ_s) with a clean steel slider for all the polymers, and the kinetic coefficient of friction (μ_k) for LDP are of the order predicted by the adhesion theory. The experimental values of μ_k are much smaller than the calculated values with TFE, FEP, and HDP because of the low specific adhesion between these polymers and their films which have transferred to the steel slider. The value of μ_k for FEP was found to be greater than that of TFE by a factor of three. Similarly, μ_k for LDP was three times that of HDP. These large differences are explained by the differences in the nature of the transferred polymer films and real areas of contact. All these polymers are potentially excellent dry-film lubricants when used as thin films on a hard backing. Friction was also determined for FEP as a function of the load in the range 100 to 10,000 grams. Static friction was not proportional to the load, and μ_s increased rapidly as the load was decreased below 1000 grams. It was concluded that the real area of contact was not proportional to the load, and that the deformation of contacting asperities was not completely plastic. Author

N63-18164 Radiation Applications Inc., Long Island City, N.Y.
THE USE OF RADIATION-INDUCED PLASTIC MEMORY TO DEVELOP NEW SPACE ERECTABLE STRUCTURES Final Report
George Odian and Bruce S. Bernstein Apr. 15, 1963 130 p 30 refs
(NASA Contract NASr-78)
(NASA CR-50447; RAI-308) OTS: $10.10 ph, $4.10 mf

The elastic memory phenomenon in irradiated (crosslinked) polyethylene has been studied for possible application to self-erecting space structures. In principle, the memory effect should allow the preparation of compactly folded crosslinked polymer shapes and structures which can be erected in space by the application of heat from the sun. The results of these studies show that the deformation conditions have no effect on the degree of restoration (memory). However, the restoration conditions are of major importance in controlling the degree of restoration of deformed polyethylene. Complete restoration (99+%) was found to require heating the polyethylene to transparency (135° C for high density, ca. 0.95–0.96, and 105° C for low density, ca. 0.91–0.92). The parameters that control the degree of restoration, the restoring forces that are involved, and the requirements for reducing the restoration temperatures are outlined. Methods of applying the memory effect to self-erecting structures are suggested for future research. R.C.M.

20 MATHEMATICS

Includes: calculation methods and theory; computers; data processing; and numerical analysis.

For related information see: 08 Communications; 09 Electronics; 10 Facilities; and 22 Navigation and Guidance.

N63-17485 Michigan U. Coll. of Engineering, Ann Arbor
DETAILED INVESTIGATION OF CAVITATION PITTING CHARACTERISTICS FROM CAVITATING VENTURI TESTS Technical Report No. 8
Lawrence L. Barinka and Frederick G. Hammitt Apr. 1963 87 p 18 refs
(NASA Contract NsG-39-60; Proj. ORA)
(NASA CR-50241; Rept. 03424-8-1)

Empirical equations are developed to evaluate the cavitation damage parameters of weight loss, mean depth of penetration, and percent damaged area, for damage to only the polished surface and for the entire samples as tested in the venturi-cavitation-damage facility. Quantitative results are presented of the contour of the cavitation pitting produced in mercury, and comparisons are made between damage produced by water and mercury in the venturi-damage facility. Author

N63-17507 Air Force Cambridge Research Labs. Electronics Research Directorate, Bedford, Mass.
A DEFORMATION METHOD FOR THE MINIMIZATION OF A QUADRATIC FUNCTION SUBJECT TO LINEAR INEQUALITY CONSTRAINTS Research Note
Samuel Zahl May 1963 31 p 4 refs
(AFCRL-63-132)

This paper presents a new method for minimizing a positive definite quadratic function subject to linear inequality constraints. It is based on a continuous deformation of the quadratic, starting from one giving rise to an almost trivial problem, and ending with the desired quadratic. The method is particularly suitable for problems involving large numbers of inequality constraints, since the size of the variable space is independent of the number of inequalities. The method is readily extended to linear programing by embedding the linear objective function in a second-degree polynomial with positive definite quadratic component, solving the resulting problem by the above method, then driving the quadratic component to zero; that is, deforming the second-degree programing problem back to the original linear one. Author

N63-17525 Brown U. Div. of Applied Mathematics, Providence, R.I.
A GENERALIZATION OF THE BELTRAMI STRESS FUNCTIONS IN CONTINUUM MECHANICS
M. E. Gurtin Apr. 1963 19 p 25 refs
(Contract Nonr-562-(25))
(Rept. 562(25)/20); Tech. Rept. 20)

Beltrami's solution of the stress equations of equilibrium for a continuous medium in the absence of body-forces is extended to include the case where the boundary of the region under consideration consists of more than a single closed surface. A concise version of Rieder's result for the stress equations is given along with a minor variant of Günther's argument. It is shown that every solution of the stress equations which is not totally self-equilibrated may be decomposed into the sum of a totally self-equilibrated solution and a biharmonic solution. R.C.M.

N63-17531 RAND Corp., Santa Monica, Calif.

THEORETICAL ANALYSIS OF NEAR-FREE-MOLECULE HYPERSONIC FLOW AT THE SHARP LEADING EDGE OF A FLAT PLATE

A. F. Charwat May 1963 68 p 12 refs
(Contract AF 49(638)-700; Project RAND)
(RM-2553-PR)

The initial interactions between a hypersonic free stream and molecules emitted (reflected diffusely) by a cold flat plate immediately downstream of its sharp leading edge are analyzed by near-free-molecule theory. The results give the variations of the pressure, shear, and heat transfer at the wall. These are found to increase downstream from the leading edge and reach a maximum plateau, and a subsequent decay of the wall-transfer properties to continuum boundary-layer values can be inferred. The magnitude and location of this plateau compare well with available viscous-pressure interaction data. An indication of the initial growth rate of the disturbed merged layer is also obtained from the analysis. It is found that this region is wedgelike, and has a slope of approximately 45 deg for all hypersonic Mach numbers and for wall-to-free-stream-temperature ratios of the order of unity. Author

N63-17538 Oak Ridge National Lab., Tenn.

A CDC-1604 SUBROUTINE PACKAGE FOR MAKING LINEAR, LOGARITHMIC AND SEMILOGARITHMIC GRAPHS USING THE CALCOMP PLOTTER

D. K. Trubey and M. B. Emmett June 24, 1963 15 p 3 refs
(Contract W-7405-eng-26)
(ONRL-3447) OTS: $0.50

A CDC-1604 subroutine package has been written to facilitate the plotting of curves and points on linear, logarithmic, and semilogarithmic graphs using the CALCOMP plotter. The subroutines accomplish the necessary computations, and prepare a magnetic tape for use by the plotter. Author

N63-17552 National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

EQUATIONS FOR THE NEWTONIAN STATIC AND DYNAMIC AERODYNAMIC COEFFICIENTS FOR A BODY OF REVOLUTION WITH AN OFFSET CENTER-OF-GRAVITY LOCATION

Robert C. Ried, Jr. and Edward E. Mayo Washington, NASA, June 1963 23 p 5 refs
(NASA TN D-1085) OTS: $0.75

Equations which are easily adaptable to machine computation are presented for the preliminary prediction of the supersonic and hypersonic stability characteristics of bodies of revolution with an arbitrary center-of-gravity location. The equations have been programed and an example of their application to a blunt reentry configuration is presented. Author

N63-17563 Directorate of Advanced Systems Planning, Aeronautical Systems Div., Wright-Patterson AFB, Ohio

ORBITAL MANEUVERS WITH FINITE THRUST ROCKETS Final Report, Apr. 1961–Aug. 1962

Robert W. Roig Jan. 1963 59 p
(ASD-TDR-62-860; AD-297504)

An iterative computer solution is devised to calculate the thrust direction, duration, and starting instant (or position), in order to transfer a vehicle from a given initial orbit to desired final orbit, taking into account the finite acceleration available. The propulsive force is assumed to be provided by a constant thrust rocket, and the thrust direction is held fixed in an inertial reference frame throughout the maneuver. The initial and final orbits must have an intersection point which is not a tangency. Some illustrative examples and the results for thrust direction and integrated thrust acceleration are presented as differences from the impulsive thrust solution. These differences are significant when the thrust-to-weight ratio of the vehicle is of the order of one or less. Author

N63-17567 Stanford U. Stanford Linear Accelerator Center, Calif.

MISALIGNMENT AND QUADRUPOLE ERROR PROBLEMS AFFECTING THE CHOICE OF MULTIPLET TYPE FOR SECTOR FOCUSING OF THE TWO-MILE ACCELERATOR Technical Report

R. H. Helm Mar. 1963 55 p 3 refs
(Contract AT(04-3)-400)
(SLAC-15) OTS: $1.25

This report presents calculations for several quadrupole multiplet combinations spaced at sector intervals. Four representative—the Spaced Doublet (SD), Close Doublet (CD), Spaced Triplet (ST) and Close Triplet (CT)—are considered. The principal object of the discussion is to compare these alternative systems in such a way as to provide a basis for deciding which would be more favorable for use in the two-mile accelerator. Consequently, the emphasis is on errors whose effects depend on the structure of the multiplet, although some structure-independent effects are included. Author

N63-17570 Sandia Corp., Albuquerque, N. Mex.

A SIMPLE ASYMPTOTICALLY CHI-SQUARE STATISTIC FOR DISTRIBUTIONS OF RUNS

Stoughton Bell Apr. 1963 31 p 18 refs
(SCR-222A) OTS: $0.75

The purposes of this investigation are to apply the gap and run tests to sequences of pseudorandom numbers and to point out, with simple arguments, some run statistics which have limiting chi-square distributions and some which do not. It was concluded that certain fairly simple run statistics have limiting distributions which are chi-square. Since the results are asymptotic, care should be taken with sample and cell sizes. Some important problems which remain are determination of the rate of convergence and the question of how to include zero length runs when seeking one statistic for success and failure runs. N.E.A.

N63-17571 Aeronautical Research Associates of Princeton, Inc., N.J.

THE SUPERSECULARITIES IN WEAK COUPLING KINETIC THEORY Technical Report

Guido Sandri Charlottesville, Va. U. School of Engineering and Applied Science, June 1963 24 p 4 refs
(Contract Nonr-3623(00); Proj. Squid)
(ARPA-6-R)

In the present paper, the singularities in the nth order s-body distribution function for the weak-coupling kinetic theory (supersecularities) are determined completely. Author

N63-17572 Aeronautical Research Labs., Wright-Patterson AFB, Ohio

THE USE OF SAMPLE RANGES AND QUASI-RANGES IN SETTING EXACT CONFIDENCE BOUNDS FOR THE POPULATION STANDARD DEVIATION. II. QUASI-RANGES OF SAMPLES FROM A NORMAL POPULATION – PROBABILITY INTEGRAL AND PERCENTAGE POINTS; EXACT CONFIDENCE BOUNDS FOR σ

H. Leon Harter Apr. 1963 238 p 10 refs
(ARL-31, Pt. II)

For a normal population, reasonably good interval estimates of the population standard deviation σ may be obtained from one suitably chosen sample quasi-range. The coefficients of the r^{th} quasi-range, w_r, in exact confidence bounds for σ are found by taking the reciprocals of percentage points of the (standardized) quasi-range $W_r = w_r/\sigma$, which are themselves found by inverse interpolation in a table of the probability integral. A discussion is given of criteria for best interval estimators, and a comparison is given of the results of interval estimation of the standard deviation σ of a normal population from one quasi-range w_r when the optimum value of r is chosen on the basis of two of these criteria: (1) minimizing the expected length of the confidence interval and (2) minimizing the mean squared deviation of the confidence bounds from the true value. Alternatively, these criteria may be stated as maximizing (1) the effectiveness or (2) the efficiency of the interval estimators. Author

N63-17576 Aeronautical Research Associates of Princeton, Inc., N.J.

THE FOUNDATIONS OF NONEQUILIBRIUM STATISTICAL MECHANICS, VOLUME I Technical Report

Guido Sandri Charlottesville, Va. U. School of Engineering and Applied Science, June 1963 89 p 12 refs Submitted for Publication
(Contract Nonr-3623(00); Proj. Squid)
(ARAP-7-P-1)

A novel philosophy of irreversible dynamics is formulated. This philosophy stems from the fact that the kinetic equations available (Boltzmann, Landau, Bogolubov-Balescu-Lenard) are essentially exact and cannot be improved. That is, for kinetic gases (those whose behavior is characterized by that of *one* typical particle) these equations constitute closed, statistically complete knowledge. This thesis is demonstrated by using a technique that separates completely the different time components exhibited by the evolution of a gas when an appropriate parameter (characteristic of the regime in which the gas is found) is small. The expansion in this parameter is pushed up to its breaking point marked by the presence of an intrinsic divergence. With this technique, the series can be pinched off at this point and remain with a closed, finite system of equations. The argument is made more compelling by the fact that the *same* divergence occurs for *all* gaseous regimes (short-range, weak-coupling, dilute weak-coupling, and Debye). Also, it is proved that not all isolated gases will eventually become kinetic. Author

N63-17577 Aeronautical Research Associates of Princeton, Inc., N.J.

THE FOUNDATIONS OF NONEQUILIBRIUM STATISTICAL MECHANICS, VOLUME II Technical Report

Guido Sandri Charlottesville, Va. U. School of Engineering and Applied Science, June 1963 80 p 7 refs Submitted for Publication
(Contract Nonr-3623(00); Proj. Squid)
(ARPA-7-P-2)

The discussion of the kinetic expansions of the Liouville equation is continued, and a discussion is presented of "superkinetic" expansions. Author

N63-17579 Weather Bureau. Meteorological Satellite Lab., Washington, D.C.

PERSPECTIVE LOCATOR GRIDS FOR TIROS PICTURES

Morris Frankel and Charles L. Bristor Oct. 1962 45 p 8 refs
(MSL-11)

Two basic computer programs, which have been developed to provide perspective geographic locator grids for Tiros satellite photographs, are described. The first program generates latitude and longitude for an X,Y point specified on the image plane. The second program treats the problem in reverse by finding the image X, Y point for a specified latitude/longitude intersection on earth. A vidicon system program for use with both of these programs has also been formulated to account for any distortions introduced by the camera system in relating light rays in object space to their counterparts in image space. Specialized versions of the latitude/longitude gridding program are being used to provide output for a mechanical data plotter and for a high-speed microfilm recorder that uses a cathode ray photo tube process whereby each grid is traced on the cathode ray tube and simultaneously recorded on microfilm. This high-speed version will be used to produce archival grids for Tiros IV; other specialized versions are being used to simulate Nimbus grids. The format of the input data card is described for the various programs and supplemental operator instructions are provided where needed. M.P.G.

N63-17629 Parke Mathematical Labs., Inc., Carlisle, Mass.

ON THE WEIGHT OF THE ELEMENTS OF BINARY GROUP CODES Scientific Report No. 5

L. Calabi and E. Myrvaagnes Mar. 1963 24 p 8 refs
(Contract AF 19(604)-7493)
(AFCRL-63-95)

Various necessary and sufficient conditions are given for the existence of codes with preassigned weights. Some properties of the weight distribution are deduced. Author

N63-17630 Parke Mathematical Labs., Inc., Carlisle, Mass.

ON THE MINIMAL WEIGHT OF BINARY GROUP CODES Scientific Report No. 7

L. Calabi and E. Myrvaagnes Mar. 1963 41 p 11 refs
(Contract AF 19(604)-7493)
(AFCRL-63-105)

Let w(n,k) be the largest integer such that there exists a binary group code (n,k) all of whose nonzero elements have weight equal to or larger than w(n,k). In this report, values of w(n,k) are given for $0<k\leq 6$ and $k\leq n\leq 100$, as well as for $0<k\leq n\leq 24$. Further, new upper and lower bounds are obtained which are easy to compute and, in certain regions, better than other known bounds. Author

N63-17651 Aberdeen Proving Ground. Ballistic Research Labs., Md.

ANALYTICAL RELATIONS BETWEEN CONSTANTS FOR GENERALIZED VOIGT AND MAXWELL VISCOELASTIC MODELS

A. S. Elder Feb. 1963 15 p 6 refs
(BRL Memo-1460)

A method of calculating the constants of a Maxwell model from the constants of the corresponding Voigt model is given. The derivation is based on residue theory and the partial fraction expansion of the transfer functions. As an example, constants for a 10-element Maxwell model are derived from the constants of a 10-element Voigt model used to approximate the mechanical properties of polyisobutylene at 25° C. Formulas for the creep and relaxation functions are also given. Author

N63-17661 National Aeronautics and Space Administration. Manned Spacecraft Center, Cape Canaveral, Fla.

DIGITAL DATA SYSTEM FOR AUTOMATIC CHECKOUT OF SPACECRAFT

Walter E. Parsons, Harold G. Johnson, and Gary J. Woods N.Y., AIAA [1963] 21 p Presented at the AIAA Space Flight Testing Conf., Cocoa Beach, Fla., Mar. 18–20, 1963

The PACE-S/C digital data system for the automatic checkout of spacecraft is described. It consists of five subsystems: the pulse-code-modulation ground-station subsystem, the computing subsystem, the display and control subsystem, the data transmission subsystem, and the onboard associated equipment (data acquisition and signal stimuli generator) subsystem. The advantages of such a system will be the ability to: (1) process and present large quantities of data in real time, (2) provide increased data accuracy, (3) provide continuous data evaluation, (4) eliminate excess cabling, (5) provide complete test documentation, (6) be program adaptive, (7) provide a variety of stimuli generation, (8) possess diagnostic capability, (9) utilize the same control room for all tests, (10) provide data familiarity during test periods, (11) make checkout data available for other users, (12) utilize available equipment, and (13) be operated with any degree of automation desired. D.E.R.

N63-17665 Grumman Aircraft Engineering Corp., Bethpage, N.Y.

LIAPUNOV STABILITY AND OPTIMAL CONTROL

Richard E. Kopp Mar. 1963 20 p 8 refs
(RN-154)

The optimal control problem from the point of view of Liapunov stability is discussed. Starting with the notion of a positive definite error function that is continually decreasing, a partial differential equation which is equivalent to the Hamilton–Jacobi equation can be immediately written. Sufficient conditions for the optimal control law, i.e., the control signal as a function of the system state, are easily derived. This development presents clearly the connection between the concepts of Liapunov stability and optimal control. After deriving sufficient conditions for the optimal control law, the necessary conditions of Pontryagin are derived for the guidance problem, i.e., determining the control variables as a function of time for specific boundary conditions. Author

N63-17673 Grumman Aircraft Engineering Corp., Bethpage, N.Y.

THE SYNTHESIS OF NONLINEAR CONTROL SYSTEMS VIA LIAPUNOV STABILITY THEORY – AN EXAMPLE

Gunther R. Geiss Feb. 1963 8 p 2 refs
(RN-153)

The synthesis of a control law for the stabilization of a freely spinning body via the fundamental concept of Liapunov's direct method is described. This approach permits the synthesis of either linear or nonlinear control, and yields the explicit determination of the isochrones of the controlled system. Author

N63-17686 Aro, Inc., Arnold Air Force Station, Tenn.

A HIGH-SPEED, SOLID-STATE, DIGITAL SCANNER FOR USE WITH THE ERA 1102 COMPUTER

G. R. Mozer and J. H. Brewer, Arnold Engineering Development Center, Mar. 1962 49 p
(Contract AF 40(600)-800, S/A 24(61-73))
(AEDC-TDR-62-61; AD-273607)

A high-speed, solid-state, digital scanner for entering data into the raw-data system of the ERA-1102 computer is described. It was built for the PWT 16-ft supersonic tunnel. The system capabilities, design considerations, theory of operation, and fabrication techniques are discussed. Author

N63-17688 Polytechnic Inst. of Brooklyn. Microwave Research Inst., N.Y.

THE REACTANCE OF A SYMMETRICAL PAIR OF STRIPS IN RECTANGULAR WAVEGUIDE

L. Lewin Apr. 23, 1963 10 p
(Contract AF 19(604)-7499)
(PIBMRI-1158-63; AFCRL-63-125)

An integral equation is found for the currents on a pair of symmetrical inductive strips in a rectangular waveguide, and is solved by known techniques to the quasi-static approximation. The integrals involved in the formula for the reactance presented to the waveguide are expressed in terms of elliptic integrals, and by a comparison of the result with the known result for a single inductive strip, the mutual inductance between a pair of strips in a waveguide is deduced. Author

N63-17698 California Inst. of Tech. Div. of Geological Sciences, Pasadena

AN "INVARIANT" PROPERTY OF SATELLITE MOTION IN A DISSIPATIVE MEDIUM

Alan B. Lees (Electronic Specialty Co.) and Bruce C. Murray Repr. from Advances in the Astronautical Sci., v. 8, 1962 p 294–302 1 ref
(NASA Grant NsG-56-60)
(NASA CR-50235)

A simple expression is derived for near-circular orbits, which related the difference in instantaneous angular momentum of a satellite as observed at two different times from the same station to the dissipative perturbing forces which acted on the satellite during that time interval. This expression is valid for an arbitrarily asymmetric gravity field. Possible applications to the measurement of very short-term atmospheric density variations and to the improvement of knowledge about the earth's shape and gravity field are described. Author

N63-17699 Stanford U. Electron Devices Lab., Calif.

COMPUTER SIMULATION OF THE ELECTRON MIXING MECHANISM IN ION PROPULSION

O. Buneman and G. P. Kooyers (Litton Industries) 1963 21 p 6 refs Presented at AIAA Electric Propulsion Conf., Colorado Springs, Colo., Mar. 11–13, 1963
(NASA Contract NAS3-2503)
(Rept. 63042)

The problem of getting electrons to emerge from an ion engine at the same rate and velocity as the ions was programed into a computer with certain idealizations such as one-dimensionality (electrons and ions are treated as sheets of charge in mutual Coulomb interaction) and simplified emission conditions (ions are injected with uniform velocity through a plane accel grid, electrons with a thermal distribution from a plane decel grid at ship potential). The ideal thrust seems to be maintained almost steadily, and good spontaneous neutralization seems to take place. It appears to be due to nonstatic space-charge fields near the electron emitter. These fields automatically admit into the ion stream electrons of approximately the required velocity, and in approximately the right number. Author

N63-17709 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

ACCELERATING FRAMES OF REFERENCE AND THE CLOCK PARADOX

Harry Lass Repr. from Am. J. Phys., v. 31, no. 4, Apr. 1963 p 274-276 6 refs
(NASA Contract NAS7-100)

The Lorentz–Einstein transformations are obtained by a method which enables one to derive a coordinate transformation between an inertial frame of reference and a noninertial accelerating system. With the aid of this transformation, one computes the explicit time for the round trip of the noninertial twin who leaves the inertial twin with initial speed, and returns by means of an acceleration. It is found that the accelerating twin returns younger than the inertial twin. Author

N63-17711 Syracuse U. Utica Coll., N.Y.

DEVELOPMENT OF NON-PARAMETRIC TECHNIQUES TO THE RELIABILITY TESTING OF AIR FORCE GROUND ELECTRONIC EQUIPMENT

Thomas J. Burke and Daniel Goss Griffiss AFB, N.Y., Rome Air Development Center, Sept. 1962 34 p 14 refs
(Contract AF 30(602)-2282)
(RADC-TDR-62-499)

This is a study of several randomization tests of statistical inference. For testing the randomness of a sequence of observations, the Runs Test and the Serial Correlation Test are discussed. Some aspects of decision theory are discussed. Among the topics considered are definitions, basic principles, the payoff matrix, utility theory, and principles of choice. Also, critical comments on utility theory and principles of choice, are given. Author

N63-17724 Cornell U. Sibley School of Mechanical Engineering, Ithaca, N.Y.

LIFETESTING TIME REQUIREMENTS TO ASSURE REQUIRED RELIABLE LIFE **Technical Report No. 9**

Henry P. Goode Oct. 1962 23 p 6 refs
(Contract Nonr-401(43))

A procedure and associated tables of factors are used in determining the minimum lifetesting time required for sample items to provide assurance at a confidence level of 95% that the items in the lot or population, from which the sample was taken, meet the life requirements specified. The life quality of the lot or population is evaluated in terms of reliable life which is the life beyond which some specified proportion of the items will survive. Tables of factors are provided for three proportions or reliability indices: 0.99, 0.90, and 0.50 (median life). In addition, another table of factors is provided for lot evaluation in terms of mean item life. The Weibull distribution is used as a failure model with the exponential distribution being included as a special case of the Weibull. Inspection of sample items is by attributes with the acceptance criterion being simply that no more than some specified number of items fail before the end of the minimum test time as computed by the use of the factors. Author

N63-17726 Drexel Inst. of Tech., Philadelphia, Pa.

A PARAMETRIC STUDY OF THE HYPERVELOCITY PERFORATION OF VISCOPLASTIC PLATES

Pei Chi Chou, Richard W. Mortimer, and Richard E. Llorens Jan. 1963 32 p 5 refs
(Contract DA-36-034-ORD-3672-RD)
(DIT-125-3)

This report presents additional theoretical results based on a viscoplastic flow model for hypervelocity perforation of thin plates. The solutions of the governing equations, including the yield strength, are obtained. The results of a parametric study performed on an IBM-1620 computer are also included. The effects on the radius of perforation due to various physical quantities are discussed. The theoretical radius of perforation and residual velocity are compared with the experimental values obtained by R. W. Watson. Author

N63-17738 Carnegie Inst. of Tech., Pittsburgh, Pa.

SIMPLE FLUIDS WITH FADING MEMORY

Bernard D. Coleman (Mellon Inst.) and Walter Noll Jan. 10, 1962 37 p 18 refs
(Contract AF 49(638)-541 and NSF Grant 5250)

This summary of some aspects of a mathematical theory of fluid behavior includes: (1) an explanation of the meaning of a simple fluid with fading memory; (2) a demonstration of how various classical linear theories of fluid and viscoelastic behavior arise naturally as first-order approximations to this mathematical theory; and (3) a description of the circumstances in which the classical theories can be expected to lose their physical applicability and are able to exhibit complete second-order extensions of the classical theories within the framework of this mathematical theory. I.v.L.

N63-17763 Harvard U. Div. of Engineering and Applied Physics, Cambridge, Mass.

ANALYSIS OF A STRUCTURE WITH A RANDOM GEOMETRY

J. Lyell Sanders, Jr. Apr. 1963 11 p
(Contract Nonr-1866(02))
(Tech. Rept. 16)

A theoretical one-dimensional structure with a random geometry is analyzed to outline the problem of determining properties of physical random structures and to point out a possible approach to the solution of the problem. Solutions are given for theoretical structures of infinite length and of finite length. While the results give no clear indication of how to approach the exact analysis of any real physical problem, they do suggest that the next step should be to invent some two-dimensional problem sufficiently simple to be analyzed. R.C.M.

N63-17767 RAND Corp., Santa Monica, Calif.

EXISTENCE AND UNIQUENESS THEOREMS IN INVARIANT IMBEDDING-I: CONSERVATION PRINCIPLES

R. Bellman, K. L. Cooke, R. Kalaba, and G. M. Wing May 1963 21 p 10 refs
(ARPA-SD-79; ARPA Order 189-61)
(RM-3611-ARPA)

This paper is devoted to the use of an important conservation property, obvious on physical grounds, in establishing the existence of the solution of a matrix Riccati equation, without recourse to the associated linear differential equation, and thus without any appeal to spectral theory. Author

N63-17770 Advisory Group for Aeronautical Research and Development, Paris (France)

THE USE OF ANALOGUE COMPUTERS IN SOLVING PROBLEMS OF FLIGHT MECHANICS

F. C. Haus (Ghent U.), J. Czinczenheim (Bréquet Aircraft Works), and L. Moulin (Training Cen. Exp. Aerodynamics) June 1960 564 p 30 refs
(AGARDograph-44)

Part I of this AGARDograph establishes the equations-of-motion for an aircraft which has a rigid structure, taking into account additional relationships introduced into the standard equations as a result of operational conditions. It also discusses the bases for calculating the general equations-of-motion for an aircraft with a nonrigid structure. The characteristics of the motion defined by these equations are easily studied by means of analog calculations. Part II deals with the principles of analog calculation, whereas Part III is concerned with the application of such calculations to the solution of certain problems relating to the mechanics of an aircraft. A number of questions concerned with the following are discussed in turn: the motion of aircraft with a rigid structure; the behavior of aircraft with a nonrigid structure; the response of aircraft fitted with an automatic pilot; the calculation of landing trajectories. Part IV illustrates a particular problem: the automatic holding of an approach trajectory. Author

N63-17799 Analytical Mechanics Associates, Inc., Uniondale, N.Y.

SINGULAR EXTREMALS IN LAWDEN'S PROBLEM OF OPTIMAL ROCKET FLIGHT

Henry J. Kelley N.Y., AIAA [1963] 8 p 7 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17-20, 1963
(NASA Contract NAS8-1549; Contract AF 29(600)-2671)
(AIAA Paper 63-221) AIAA: $0.50 members, $1.00 nonmembers

The present paper derives the singular extremals of Lawden's problem by means of the Legendre-Clebsch necessary condition applied in a transformed system of state and control variables. These are obtained as circular orbits along which the thrust is zero and intermediate thrust arcs as found in Lawden's analysis. Since these solutions satisfy only the weak form of the Legendre-Clebsch condition, i.e., the extremals are singular in the transformed system of variables, the question of their minimality remains unanswered. Author

N63-17884 Aberdeen Proving Ground. Ballistic Research Labs., Md.

THE FORAST PROGRAMMING LANGUAGE FOR ORDVAC AND BRLESC

Lloyd W. Campbell and Glenn A. Beck Aug. 1962 125 p 3 refs
(BRL-1172)

FORAST is a problem-oriented programing language designed for use on the ORDVAC and BRLESC computers at BRL. Although it was designed for professional programers, FORAST contains sufficient simple concepts to make it usable by a novice or journeyman. It permits the use of arithmetic formulas, some English word statements, and each computer accepts its own symbolic or absolute machine language. The latter feature permits the professional programer to use the full power of each computer. Author

N63-18017 Michigan U., Ann Arbor

ORDER STRUCTURES AND SPECTRAL THEORY Final Report, 1 July 1962-30 June 1963

H. H. Schaefer May 31, 1963 3 p
(Grant DA-ARO(D)-31-124-G87)
(AROD-2800-11)

The spectrum of positive operators is investigated. The influence of the positivity of the linear operator, T, defined on an ordered Banach space, upon its spectral behavior is generally only felt on the spectral circle. However, further results can be obtained if the spaces and orderings considered are of a more concrete nature. The point spectrum on $\lambda = r$ of certain positive operators, T, on spaces L^1(mu) is found to be of cyclic nature and can be generalized with respect to the class of operators and the class of spaces for which it is true, in particular, the space L^P(mu) where $(1 \leq p \leq \infty)$. Let A be a positive matrix operator on a space L^P of spectral radius one and such that some eigenvector (for $\lambda = 1$) of the transpose A^T has all coordinates positive. If the eigenvalue of modulus 1 is not a root of unity, then every number of modulus 1 is an eigenvalue of A. On the other hand, if A has strictly positive diagonal entries, then 1 is the only possible eigenvalue of A of modulus 1. D.E.R.

N63-18030 Training Center for Experimental Aerodynamics, Rhode-Saint-Genèse (Belgium)

AN EXACT SOLUTION TO THE COMPRESSIBLE LAMINAR BOUNDARY-LAYER EQUATION FOR THE FLAT PLATE WITH CONSTANT HEAT FLUX

Jean J. Ginoux May 1963 48 p 8 refs
(TCEA-TN-11)

It is shown that the ratio of the heat-transfer coefficients for constant heat-flux and for constant temperature (i.e., isothermal case) is a constant independent of the Reynolds number, Mach number, and Prandtl number. This property indicates that experimental results are obtained with a constant heat-flux technique which are simply related to results that could be obtained with the usual isothermal method. The theory is experimentally checked by using an improved steady-state technique derived from Seban's, which gives "uncorrected" data that are in agreement with the theory to within 10% at M = 2 and 20% at low speed. Author

N63-18051 Ohio State U. Research Foundation. Antenna Lab., Columbus

THE SOLUTION OF AN INTEGRAL EQUATION FOR THE LUNAR SCATTERING FUNCTION

R. T. Compton, Jr. Apr. 1, 1963 16 p
(NASA Grant NsG-213-61)
(Rept. 1388-8) OTS: $1.60 ph, $0.80 mf

The problem of measuring the scattering properties of the moon with an unmodulated continuous wave radar was considered. It was assumed that the average scattering cross section per unit area of the lunar surface depended only on the angle between the direction of incidence and the normal to the surface. With this assumption, it was possible to calculate the scattering function from the power-density spectrum of the echo signal. The scattering function was found as the solution to an Abel-type integral equation. I.v.L.

N63-18056 California U., Berkeley. Lawrence Radiation Lab.

EFFICIENCY OF EQUATIONS OF STATE FOR GASEOUS MIXTURES AT THE CRITICAL LOCUS. I. APPLICATION OF THE EQUATION OF BENEDICT, WEBB, AND RUBIN. II. FURTHER IMPROVEMENTS OF AN EQUATION OF STATE

Frank Jay Ackerman (M.S. Thesis) Feb. 1, 1963 72 p 59 refs
(Contract W-7405-eng-48)
(UCRL-10650) OTS: $1.50

The present investigation compares the eight-parameter equation-of-state proposed by Benedict, Webb, and Rubin with observed data and a two-parameter equation of Redlich and Kwong. Contrary to expectation, the more elaborate equation furnishes sometimes entirely unreasonable results. This failure is related to the fact that the values of the eight parameters are, in general, not sufficiently well defined by observations in a limited range of temperature and pressure. An algebraic equation-of-state is desirable because it leads shortly to fugacity coefficients, which are the practically important objectives in the study of the variables of state. The first part of this thesis illustrates the advantages and shortcomings of the equation of Redlich and Kwong. The improved equation obtained in Part II comes close to the accuracy of Pitzer's tables, and at the same time permits an algebraic derivation of fugacity coefficients. Author

N63-18130 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

ON THE ERROR PROPAGATION OF SOME INTERPOLATION FORMULAS FOR SECOND-ORDER DIFFERENTIAL EQUATIONS

Erwin Fehlberg Washington, NASA, July 1963 31 p refs
(NASA TN D-1834) OTS: $1.00

Simple extrapolation formulas are presented for the propagation of the truncation error for interpolation formulas integrating $y'' = f(x,y)$. These error formulas are applied to the interpolation formulas of Milne and Gauss, and their accuracy is illustrated by examples. The error formulas are extended to cover the case of interpolation formulas for $y'' = f(x,y,y')$. The interpolation formulas of Milne and Gauss are supplemented by new formulas for y' in such a way that the combined formulas have the same small error parameter E as the original formulas of Milne or Gauss. Examples demonstrate the accuracy of the error formulas for these new interpolation formulas. Author

N63-18149 Stanford U. Applied Mathematics and Statistics Labs., Calif.
ON THE NECESSARY CONDITION FOR OPTIMAL CONTROL OF NONLINEAR SYSTEMS
Hubert Halkin June 13, 1963 113 p 20 refs
(Contract Nonr-225(11))
(Tech. Rept. 116)

This review on the necessary condition for optimal control of nonlinear systems covers the following: (1) a precise formulation to the fundamental problem of optimal control, (2) comoving coordinate space along a given trajectory, (3) a set of reachable events, (4) the necessary conditions for the optimal control of a nonlinear dynamical system, (5) norms for the space of control functions and for the spaces of trajectories, (6) curvilinear coordinate space along a given trajectory, (7) the approximation of the comparison trajectories in the comoving space along a given trajectory, (8) the range of a vector integral over Borel sets, (9) an application of Brouwer's fixed point theorem, and (10) proofs of the theorems presented under item (4). I.v.L.

N63-18160 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
TABLES FOR THE INTEGRAL OF THE CIRCULAR BIVARIATE NORMAL FREQUENCY FUNCTION
William L. Weaver and Kathleen C. Wicker Washington, NASA, July 1963 38 p 7 refs
(NASA TN D-1819) OTS: $1.00

Tables are presented for the integral of the offset circular bivariate normal (circular binormal) distribution function over two types of regions of the distribution: (1) circles centered at the origin of coordinate axes, and (2) infinite sectors bounded on one side by an infinite radius vector passing through the origin. The tables can be used to determine the integral of the circular function over annular regions about the origin of coordinate axes, and the integral over regions bounded by two infinite radius vectors of arbitrary direction. The evaluation of the integral was performed numerically by using the quadrature formulas of Gauss. Author

N63-18171 Parke Mathematical Labs., Inc., Carlisle, Mass.
BASIC FEATURES COMMON TO SOME COMBINATORIAL COVERING PROBLEMS Scientific Report No. 2
J. A. Riley Feb. 1963 26 p 14 refs
(Contract AF 19(628)-2417)
(AFCRL-63-130)

An abstract covering problem is formulated which includes, as special cases, the prime implicant problem, the usual set-theoretic covering and systems of representatives problems; and the problems of externally stable sets, 1-widths of matrices, and minimal including sums. The known methods of solution are extended to the general case. Author

N63-18183 Air Proving Ground Center, Eglin AFB, Fla.
ROCKET FIN SETTING PROGRAM FOR THE LGP-30 COMPUTER Final Report
Robert Kramer May 1963 112 p 1 ref
(APGC-TDR-63-30)

The purpose of this report is to present a method of solution for setting fins and determining wedge sizes for non-cantable fins of vertical probe rockets. The vehicles discussed are the Nike-Cajun, Honest John-Nike-Nike, Nike-Apache, and the Exos. Section 1 is a discussion of the applicable theory and equations, and Section 2 is a discussion of the LGP-30 computer program used for the fin setting and wedge-size solution. Author

21 METEOROLOGY

Includes: climatology; weather forecasting; lower atmosphere studies; and oceanography.

For related information see: 05 Astronomy and Astrophysics; 12 Geophysics; and 29 Space Sciences.

N63-17527 Army Electronics Research and Development Activity. Meteorological Support Div., White Sands Missile Range, N. Mex.
METEOROLOGICAL DATA REPORT – NIKE-APACHE SR-008
Gordon L. Dunaway June 1963 33 p 1 ref
(ERDA-29)

Meteorological data gathered for the launching of Nike-Apache SR-008 are presented. The data appear, along with calculated ballistic data, in appendixes. Author

N63-17574 Texas U. Electrical Engineering Research Lab., Austin
THE DESIGN OF AN ENCLOSURE FOR THE INVESTIGATION OF ATMOSPHERIC THERMAL RADIATION PHENOMENA Final Report
Claude E. Duchon and Glen E. Willis Mar. 31, 1963 34 p 7 refs
(Contract AF 19(604)-7279)
(Rept. 4-08; AFCRL-63-496)

The influence upon each other of turbulent and radiative heat transfer in the lowest few meters of the atmosphere has stimulated interest in finding a means of eliminating turbulence while at the same time permitting longwave radiation to continue unimpeded. The purpose is to investigate meteorological phenomena in an environment where the primary mechanism for heat transfer is infrared radiation. To effect the elimination of mixing, an enclosure has been designed to be placed over the ground at night. The enclosure consists of four highly polished aluminum walls and a polyethylene film cover. The major problem in the use of the enclosure is the thermal effects of the walls on the internal environment. Currently, the importance of these effects, based on both theoretical and experimental grounds, is being evaluated. In addition to this work, a longwave recalibration has been made of three Middleton radiometers. Author

N63-17694 Columbia U. Lamont Geological Observatory, Palisades, N.Y.
THE SEISMIC MOTION OF THE DEEP OCEAN FLOOR Annual Report, 1 Apr. 1961 to 31 Dec. 1962
D. D. Prentiss and J. I. Ewing [1962] 98 p 5 refs
(Contract AF 19(604)-8357; Proj: VELA-UNIFORM)
(AFCRL-63-250)

Results of the first measurements of ambient seismic noise of the deep ocean floor below 2000 fathoms are presented. The measurements were made with vertical component seismometers at nine locations. At five stations in the Atlantic Ocean, amplitudes observed at 1 cps were 100 millimicrons at one site, 35 millimicrons at two sites, and less than 1 millimicron at the other two sites. At a station in the Gulf of Mexico, amplitudes of 35 millimicrons at 1 cps were observed. Amplitudes of about 1 millimicron at 1 cps were observed at three sites in the Arctic Ocean. Author

N63-17752 Stanford Research Inst., Menlo Park, Calif.
A METEOROLOGICAL STUDY OF COLD CLOUDS AS RELATED TO SATELLITE INFRARED HORIZON SENSORS Scientific Report 1
John E. Alder Feb. 1963 68 p 16 refs
(Contract AF 19(628)-1681)
(AFCRL-63-413)

A cold cloud is defined as one that radiates infrared energy at a low temperature (about 200° K). The problems that present infrared horizon sensors on space vehicles are experiencing from cold clouds are discussed. Efforts to design new sensors to overcome these problems are also mentioned. Conditions favorable for cold clouds are described as the high, cold tropopause of a tropical air mass and a weather disturbance in this tropical air capable of generating dense cirriform clouds near the cold tropopause and associated lower opaque clouds to shut off radiation from lower levels. These weather disturbances may be in the form of an active Intertropical Convergence Zone, tropical cyclones, monsoons, and extratropical cyclones. Distributions of these conditions favorable for cold clouds over the earth are discussed and illustrated with photographs. Particular emphasis is placed on the possibilities for cold clouds associated with an extratropical cyclone. Specific examples of this type of storm are studied, including one that was viewed by the infrared sensors of Tiros II. A model is formulated showing the location of an area favorable for cold clouds in an occluding extratropical cyclone. The association of a poleward-moving jet stream with a poleward-extending area favorable for cold clouds in an extratropical cyclone is noted. Therefore, a longitudinal frequency distribution of such areas is implied in a longitudinal frequency distribution of poleward-moving jet streams. Author

N63-17755 France. Direction de la Météorologie Nationale, Paris
DISTRIBUTION AND DURATION OF PRECIPITATIONS IN WESTERN AFRICA [RÉPARTITION ET DURÉE DES PRÉCIPITATIONS EN AFRIQUE OCCIDENTALE]
G. A. Delorme Mar. 1963 30 p 1 ref In FRENCH
(Monographies de la Météorologie Nationale No. 28)

A number of stations in western Africa can actually accomplish permanent or quasi-permanent weather observations. Their observations were used for a statistical study of precipitation because the actual knowledge of rainfall variations is very limited for these regions. The study was made using data from 20 stations, each providing 8 observations daily at three-hour intervals carried out from 1951 to 1955; this totals 14,608 observations for each station. The data were analyzed to give results in the following areas: (1) the mean probability of precipitation, (2) the mean duration of precipitation, (3) the mean intensity of precipitation, (4) the types of precipitation, and (5) the succession of different types of precipitation. M.P.G.

N63-17783 Massachusetts Inst. of Tech., Cambridge
STUDIES OF THE STRATOSPHERIC GENERAL CIRCULATION Final Report, Planetary Circulations Project
Victor P. Starr et al Nov. 30, 1962 362 p 225 refs
(Contract AF 19(604)-5223)
(AFCRL-63-435)

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7. ANALYSIS OF THE U AND V FIELDS IN THE VICINITY OF THE POLES A. A. Barnes, Jr. p 350–353 2 refs (See N63-17790 16-21)
8. A PRELIMINARY STUDY OF THE POTENTIAL TO KINETIC ENERGY CONVERSION PROCESS IN THE STRATOSPHERE R. M. White and G. F. Nolan p 354–357 4 refs (See N63-17791 16-21)

N63-17784 Massachusetts Inst. of Tech., Cambridge
QUESTIONS CONCERNING THE ENERGY OF STRATOSPHERIC MOTIONS
Victor P. Starr *In its* Studies of the Stratospheric General Circulation Nov. 30, 1962 p 1–7 5 refs Repr. from Arch. Meteorol., Geophys. Bioklimatol., Ser. A (Vienna), v. 12, no. 1, 1960 (See N63-17783 16-21)
(Contract AF 19(604)-5223)

In this article, the theoretical conclusion is reached that the vertical transport of kinetic energy in the atmosphere from one horizontal layer to another is effected solely by an area over the internal boundary, of the kinetic energy per unit volume multiplied by the vertical velocity. Speculations are made as to whether the kinetic energy in stratospheric levels is maintained against friction through such a vertical transport from other levels, or whether the needed supply is derived from convective sources *in situ*. Author

N63-17785 Massachusetts Inst. of Tech., Cambridge
KINETIC AND POTENTIAL ENERGY BETWEEN 100 mb AND 10 mb DURING THE FIRST SIX MONTHS OF THE IGY
Arnold Appleton Barnes, Jr. (Ph.D. Thesis) *In its* Studies of the Stratospheric General Circulation Nov. 30, 1962 p 8–131 35 refs (See N63-17783 16-21)

Using the x,y,p coordinate system, the integral equations of the time rate of change of (1) total kinetic energy, (2) potential plus internal energy, and (3) zonal kinetic energy for the stratosphere over the Northern Hemisphere are given in a form suitable for numerical approximation of the individual integrals. The method of approximation separates each integral into a mean term contribution, and contributions due to the eddy terms. Observations at 100, 50, 30, and 10 millibars from 211 Northern Hemisphere stations for the periods July through September 1957 and October through December 1957 were used to evaluate the terms. Author

N63-17786 Massachusetts Inst. of Tech., Cambridge
MOMENTUM BALANCE OF THE STRATOSPHERE DURING THE IGY
Robert Earl Dickinson *In its* Studies of the Stratospheric General Circulation Nov. 30, 1962 p 132–167 18 refs (See N63-17783 16-21)

A differential form of the equation of angular momentum balance is given, and data from one year of actual wind observations in the stratosphere are used to discuss the terms involved. Horizontal eddy-momentum convergences are largest at 100 mb near the maximum of the tropospheric jet, and at 50 and 30 mb in the vicinity of the polar night jet. The momentum divergences south of 30° N at 50 mb and 30 mb are sufficiently small to show that the seasonal changes of momentum cannot be due only to these eddy fluxes. No process could be found to give a stratospheric momentum balance if a northward meridional circulation in middle latitudes were assumed to exist. Author

N63-17787 Massachusetts Inst. of Tech., Cambridge
DIRECT MEASUREMENT OF THE MERIDIONAL CIRCULATION IN THE STRATOSPHERE DURING THE IGY
Abraham H. Oort *In its* Studies of the Stratospheric General Circulation Nov. 30, 1962 p 168–206 15 refs (See N63-17783 16-21)

The horizontal component of the meridional circulation at the 100-, 50-, and 30-mb levels in the stratosphere is measured for the IGY period July 1957 through June 1958. Data from approximately 240 stations, well distributed over the Northern Hemisphere, are used in the hemispheric analysis of the north-south component of the wind. A separation of the data into four periods of three months enabled us to determine seasonal variations. In addition, 00Z and 12Z data were treated separately in order to detect possible diurnal effects. Values of the mean meridional circulation, i.e., the zonal average of the time mean north-south component of the wind, are presented at every 5° latitude from the equator to 80° N. Author

N63-17788 Massachusetts Inst. of Tech., Cambridge
TRANSFER THROUGH THE TROPOPAUSE AND WITHIN THE STRATOSPHERE
Reginald E. Newell *In its* Studies of the Stratospheric General Circulation Nov. 30, 1962 p 207–303 119 refs Submitted to the Roy. Meteorol. Soc., Dec. 1961 (See N63-17783 16-21)

The evidence for tropospheric-stratospheric mass exchange is reviewed. A large fraction of the exchange appears to occur in the vicinity of the middle-latitude tropopause discontinuity and the concomitant jet stream. Calculations of the flux of radioactive substances in the troposphere support this view. Computations of the horizontal flux of ozone in the lower stratosphere are presented for the IGY period divided into three-month seasons. Indications are that the large-scale quasi-horizontal transient eddies can transport ozone polewards in sufficient quantities to account for the spring buildup of ozone. Such large-scale mixing, as opposed to mean meridional motions, also allows explanation of the distribution of radioactive tungsten in the stratosphere. Transports appear to be polewards and downwards between latitudes 20° and 60°. Independent meteorological evidence, in the form of isentropic cross-sections and values of the covariance between the meridional and vertical components of the wind, support the mixing scheme. The observed counter-gradient eddy flux of heat can be explained from the model. Distributions of certain other trace substances are not at variance with the model. Author

N63-17789 Massachusetts Inst. of Tech., Cambridge
THE GENERAL CIRCULATION OF THE ATMOSPHERE AND ITS EFFECTS ON THE MOVEMENT OF TRACE SUBSTANCES
Reginald E. Newell *In its* Studies of the Stratospheric General Circulation Nov. 30, 1962 p 304-347 27 refs Presented at the Symp. on Trace Gases and Nat. and Artificial Radioactivity in the Atmosphere, Utrecht, Netherlands, Aug. 8–14, 1962 (See N63-17783 16-21)

A brief summary is made of present knowledge of horizontal and vertical motions in the atmosphere, with particular reference to large-scale motions which may be expected to redistribute trace substances over long time periods. Mean motions, standing eddy motions, and transient eddy motions are defined and discussed separately, with variance data being used as a measure of the transport properties of the eddies. Hemispheric data concerning both horizontal and vertical components are available up to about 25 km, with limited samples of horizontal component data to 60 km. Indications are that eddy motions, rather than mean motions, are the main transport process up to 25 km. Variance data show maxima in both horizontal and vertical components in the vicinity of the tropospheric jet stream, and in the vicinity of the polar night stratospheric jet. In the troposphere, the smallest values of both horizontal and vertical variances occur in the low altitudes of the tropics. The data are applied to a discussion of the distribution of long-lived fission products in the atmosphere. A possible explanation for the inclination of the concentration isolines of the trace substances to the isentropic surfaces is presented. Finally, the general approach is applied to the particular case of the budget of ozone in the stratosphere. Author

N63-17790 Massachusetts Inst. of Tech., Cambridge
ANALYSIS OF THE U AND V FIELDS IN THE VICINITY OF THE POLES
Arnold Appleton Barnes, Jr. *In its* Studies of the Stratospheric General Circulation Nov. 30, 1962 p 350–353 2 refs Repr. from Monthly Weather Rev., Jan. 1963 (See N63-17783 16-21)
(Contracts AF 19(604)-5223 and AT(30-1)-2241)

The fields of the eastward (*U*) and northward (*V*) components of the wind are investigated mathematically. Maps whose point values are the products of the point values of two maps are also investigated. Rules are given to aid in the analysis of these types of maps. Author

N63-17791 Massachusetts Inst. of Tech., Cambridge
A PRELIMINARY STUDY OF THE POTENTIAL TO KINETIC ENERGY CONVERSION PROCESS IN THE STRATOSPHERE
Robert M. White and George F. Nolan *In its* Studies of the Stratospheric General Circulation Nov. 30, 1962 p 354–357 4 refs Repr. from Tellus (Stockholm), v. 12, no. 2, 1960 (See N63-17783 16-21)

The potential to kinetic energy conversion process in the lower stratosphere associated with the vertical exchange of warm and cold air is evaluated using adiabatically derived vertical velocities for the North American region for a five-day period. Preliminary results suggest the possibility that, on the average, the kinetic energy of stratospheric motions may not result from a conversion of potential energy within the stratosphere by this process. The further implication is that stratospheric motions are maintained by the motions in the adjacent layers of the atmosphere. Author

N63-17912 National Severe Storms Project, Kansas City, Mo.
500-KC./SEC. SFERICS STUDIES IN SEVERE STORMS
Douglas A. Kohl and John E. Miller (General Mills, Inc.) Washington, Weather Bureau, Apr. 1963 41 p 7 refs
(Contract Cwb-10346)
(NSSP-13)

The count rate of "sferics" monitored at 500 kilocycles per second has been related to severe weather events occurring within the detection area during a 48-day period. Sferics activity was always in evidence prior to and during severe weather occurrences. Few severe-weather events occurred after the sferics count rate began to decrease. Radar evidence of "hard" echoes from the vicinity of a severe weather event occurred prior to a rapid increase in sferics which immediately preceded the event. Author

N63-17998 Chicago U. Weather Forecasting Research Center, Ill.
ON THE INFLUENCE OF RELEASED LATENT HEAT ON CYCLONE DEVELOPMENT Scientific Report No. 10
Maurice B. Danard June 1963 56 p 28 refs
(Contract AF 19(604)-7230)
(AFCRL-63-623)

The influences of release of latent heat of vaporization on vertical motion, production of kinetic energy, and development of low-level vorticity have been investigated. The vertical motion was obtained by solving the customary (diagnostic) omega-equation, making allowance for horizontal variations of the static stability. The results were compared with vertical velocities computed by kinematical techniques, and it was found that it was necessary to include the effect of released latent heat in order to obtain satisfactory agreement between the two sets of data. Experimental computations showed that the effects of spatial variations of the static stability were important outside regions of condensation. Numerical solutions, with and without inclusion of released latent heat, were used to obtain ageostrophic wind components and their effect upon the production of kinetic energy and vorticity. Author

N63-18074 Army Electronics Research and Development Lab., Fort Monmouth, N.J.
ANALYSIS OF THE ELECTROSTATIC FIELD OF A LIGHTNING STROKE
H. W. Kasemir Nov. 1962 16 p 6 refs
(USAELRDL-TR-2321)

During the summer of 1961, the electrostatic field of lightning strokes in the frequency range from 0 to 100 cps was recorded. Simultaneously, the distance from the lightning stroke to the recording station was determined by triangulation. This, combined with the electrostatic theory, allows a detailed analysis of the electric field of the lightning stroke. The results of this analysis are discussed. Author

N63-18153 Cornell U. Center for Radiophysics and Space Research, Ithaca, N.Y.
CHARACTERISTICS OF TRACKABLE RADAR ANGELS Scientific Report No. 2
T. H. Roelofs Jan. 16, 1963 58 p 12 refs
(Contract AF 19(604)-6160)
(AFCRL-63-434; CRSR-137)

Clear air radar angels were tracked with an FPS-16 radar at Wallops Island, Virginia. Observations were made at different times of the year, under a variety of weather conditions. On cloudy days, echoes having characteristics similar to clear air angels were tracked. Data consist of flight trajectories of the echoes and a record of power returned. Radiosonde profiles of the atmosphere were obtained from an on-site weather station. Evidence is given that indicates the meteorological nature of angels. A tentative model is suggested which would account for most of the observed characteristics. Author

N63-18154 Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
METEOROLOGICAL DATA REPORT, AEROBEE NE 3.140 NRL-73
Marjorie Mc Lardie Hoidale June 1963 34 p refs
(ERDA-33)

Meteorological data gathered for the launching of Aerobee NE 3.140 (NRL-73) are presented. The data appear, along with calculated ballistic data, in appendixes. Author

N63-18156 Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
METEOROLOGICAL DATA REPORT, NIKE-APACHE SR-012 AND SR-013
Gordon L. Dunaway June 1963 59 p refs
(ERDA-38)

Meteorological data gathered for the launching of Nike-Apache SR-012 and SR-013 are presented. The data appear, along with calculated ballistic data, in appendixes. Author

N63-18157 Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
METEOROLOGICAL DATA REPORT, AEROBEE NB 3.130 NRL-77
Gordon L. Dunaway June 1963 39 p refs
(ERDA-39)

Meteorological data gathered for the launching of Aerobee NB 3.130 (NRL-77) are presented. The data appear, along with calculated ballistic data, in appendixes. Author

N63-18187 American Meteorological Society, Boston, Mass.
MODIFICATION OF HAILSTONE GROWTH [ZUR BEEINFLUSSUNG DES HAGELKORNWACHSTUMS]
R. List 1962 13 p 10 refs Transl. from Z. Angew. Phys., v. 13 No. 4, 1962 p 393–401
(Contract AF 19(604)-6113)
(TG-189+)

To decrease the accretion rate of a growing hailstone, its deposit has to be made dry. Under such conditions, a spherical form is preferred to an ellipsoidal one. The growth rate of the former is lower than that of the latter to a factor of two. The accretion rate can be slowed down further when the small cloud particles are partially frozen. In a solid state they will mostly be rejected from the surface of the (dry) hailstone, and do not contribute to growth. This decrease in accretion rate will normally lower the hail damage. But there exists another method which produces hailstones with a very high rate of liquid water. Such spongy particles burst as soon as they hit the ground. Author

22 NAVIGATION AND GUIDANCE

Includes: autopilots; star tracking; inertial platforms; and traffic control.

For related information see: **06 Auxiliary Systems; 08 Communications; 09 Electronics; 10 Facilities; 15 Instrumentation; 20 Mathematics; and 29 Space Sciences.**

N63-17520 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A METHOD OF DETERMINING THE SOURCE OF ERRORS IN GUIDANCE MEASUREMENTS AND THE RESULTANT ERRORS IN EARTH-FIXED COMPONENTS
R. A. Chapman N.Y., AIAA [1963] 33 p Presented at AIAA Space Flight Testing Conf., Cocoa Beach, Fla., Mar. 18–20, 1963
(AIAA Paper 63077) AIAA: $0.50 members, $1.00 non-members

Guidance errors —resulting from (1) initial misalignments of both the accelerometers and stabilizing gyros, (2) drift of the stabilized element during flight, and (3) errors in measuring the vehicle motion —are analyzed, and the resultant effects of these errors on the set of conditions required to accomplish a particular mission are presented. Ideal and perturbed trajectories were computed for a two-stage Saturn C-1 vehicle with a mission to put a payload into a 555-km orbit. Differences between the perturbed and ideal orbits represent the guidance intelligence errors. Guidance system hardware errors are found to produce additive effects on the accelerometer outputs, time integrals of the vehicle motions, and initial velocities. D.E.R.

N63-17586 Federal Aviation Agency. Systems Research and Development Service, Atlantic City, N.J.
STANDARD DIRECTIONAL LOCALIZER OVERFLIGHT INTERFERENCE Final Report
F. W. Marschall July 1962 52 p

The reflection interference effects of overflying aircraft on ILS localizer receivers in the landing area are described. The data were derived from field tests and mathematical analysis, and include both static and dynamic receivers. Field test data were gathered using a standard directional waveguide localizer. Interference is defined as Course Deviation Indicator (CDI) deviations of ten microamperes or more at a frequency of one cycle per second or less and having a duration of one-half second or more. A typical volume is represented in which one aircraft would cause interference to a second aircraft that is in a landing configuration near touchdown. This volume was derived from the results of field tests and mathematical analysis. Here the interfered aircraft is landing at 210 feet per second (fps), 10,000 feet from the localizer, and the interfering aircraft is a DC-3 traveling in the same direction at 340 fps. Interference volumes will have different geometries and positions depending upon the geometry of the aircraft, the velocities of the aircraft, the cross section of the interfering aircraft, the beam structures of the antennas, and the criteria used for interference. Interference volumes are limited in azimuth to plus and minus 8° because of the narrow azimuth beam structure of the waveguide localizer antenna. Interference volumes are limited in altitude by the RF cross sectional area of the interfering aircraft and the vertical lobe structure of the localizer antenna. Volumes of interference parallel to the runway that are generated by aircraft flying parallel to the runway are primarily limited by the frequency of the interference. In the field tests, interference volumes to static receivers were more predictable and in most instances of greater duration than interference to dynamic receivers. Author

N63-17924 Raytheon Co., Bedford, Mass.
OPTIMAL MEASUREMENT AND VELOCITY CORRECTION PROGRAMS FOR MIDCOURSE GUIDANCE
Walter F. Denham and Jason L. Speyer N.Y., AIAA [1963] 41 p 5 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963 Work performed in support of the M.I.T. Instrumentation Lab.
(NASA Contract NAS9-498)
(AIAA Paper 63-222) AIAA: $0.50 members, $1.00 nonmembers

The estimation and control of the perturbations in the preplanned midcourse portion of a space-mission trajectory are considered. The problem investigated is the optimization of the measurement program and/or the feedback control-gain program. The performance index is a scalar function of the expected values of quadratic forms in the perturbations and/or in the errors in the estimates of perturbations. Necessary conditions for the desired extremal solutions and a steepest-ascent computation procedure for obtaining approximate optimizations are presented. A numerical example in which the sequence of stars and near-body horizons to be sighted for the midcourse phase of a lunar mission is selected to minimize the terminal point uncertainty in position (or a weighted average of position and velocity uncertainties) is presented. The numerical scheme is shown to converge to essentially the same result starting with various nominal measurement programs. Author

N63-18109 Michigan U. Inst. of Science and Tech., Ann Arbor
OPTIMAL DOPPLER-INERTIAL SYSTEMS WITH TRANSIENT CONSTRAINTS
William A. Porter and Marshall Kuo June 1963 52 p 4 refs
(Contract DA-36-039-SC-78801; Proj. Michigan)
(Rept. 2900-391-T)

Most statistically optimum Doppler-inertial systems have poor transient characteristics. To achieve near-optimal statistical performance with acceptable transient characteristics, an optimization with a transient constraint has been carried out. The results indicate that an attractive compromise between statistical and transient characteristics can be found for a large class of systems. Author

N63-18134 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
RANDOM DEVIATIONS FROM STABILIZED CRUISE ALTITUDE OF COMMERCIAL TRANSPORTS AT ALTITUDES UP TO 40,000 FEET WITH AUTOPILOT IN ALTITUDE HOLD
Joseph J. Kolnick and Barbara S. Bentley Washington, NASA, July 1963 38 p 3 refs
(NASA TN D-1950) OTS: $1.00

The random deviations from stabilized cruise altitudes of 19 commercial transports on scheduled, passenger-carrying flights, at altitudes up to 40,000 feet, have been evaluated from NASA VGH records. The airplanes represented 10 aircraft types, of which 4 were turbojets, 3 were turboprops, and 3 were piston engines. They were operated by nine United States airlines for a period of about 1 year over both land and ocean routes, covering 9,950 hours of cruise time. The results of the evaluation showed that the airplanes flew within 200 feet of their stabilized cruise altitude for at least 99.5 percent of the cruise time for operation with autopilot in altitude-hold control, and for at least 94.5 percent of the cruise time for operation with manual control. For 0.3 percent of the cruise time, the altitude deviations from stabilized cruise altitudes for operation with autopilot in altitude-hold control did not exceed 250 feet for any of the airplanes over the altitude range up to 40,000 feet. For 0.3 percent of the cruise time, the altitude deviations for manual control were about two to three times those for operation with autopilot in altitude-hold control. No differences in altitude deviations due to altitude, airplane type, airline, route, and season of the year were found. Author

23 PHYSICS, GENERAL

Includes: acoustics; cryogenics; optics; and thermodynamics.
For astrophysics see: 05 Astronomy and Astrophysics.
For related information see: 12 Geophysics; 29 Space Sciences; 24 Physics, Plasma; and 24 Physics, Solid-State.

N63-17486 RAND Corp., Santa Monica, Calif.
A SIMPLE METHOD OF DETERMINING THE EFFECT OF REACTOR TEMPERATURE ON CRITICALITY CONDITIONS
B. Pinkel, A. Leonard, and G. B. W. Young June 1963 39 p 3 refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-3089-PR)

An analysis is made of the effect of reactor temperature on criticality conditions, and simple relations are obtained for calculating these effects. The buckling (and hence reactor size for criticality) may be expressed as a function of the fission, capture, and scatter cross sections of the reactor materials averaged over the flux spectrum. If these parameter averages are known for one reactor temperature, then the simple relations derived in this study allow computation for other reactor temperatures. A substantial simplification of the analysis results from the assumption that the major part of the influence of reactor temperature comes from the changes in the cross sections and in the values of the flux distribution in the vicinity of thermal energy. Good agreement is obtained between the values computed from the equations and the values obtained from an 18-group machine calculation, performed for a series of reactors covering a temperature range from 25° C to 1450° C. Author

N63-17496 European Atomic Energy Community, Brussels (Belgium)

METHODS AND APPLICATIONS OF ULTRA-HIGH VACUUM TECHNIQUES [METHODEN UND ANWENDUNGEN DER ULTRA-HOCHVAKUUM-TECHNIK]

H. Eschbach Joint Nuclear Research Center, Central Nuclear Measurements Bureau, Geel Establishment (Belgium), Apr. 1963 23 p 67 refs In GERMAN; English summary
(EUR-231.d) Available from Belgian American Bank and Trust Co., N.Y., Account No. 121.86: 40 Belg. Fr.

A description is given of certain important methods of generating and measuring extremely low pressures; the factors which determine the final vacuum are discussed, and it is pointed out that measurements made in an ultra-high vacuum—as well as such in vacuum physics in general—are rather difficult. Among the various applications mentioned, ultra-high vacuum evaporating techniques and the generation of an ultra-high vacuum in large-size altitude chambers are of particular interest. Author

N63-17582 Stanford Research Inst., Menlo Park, Calif.

ONE-SIDED MULTIPACTOR DISCHARGE MODES

E. F. Vance and J. E. Nanevicz Apr. 1963 44 p 74 refs
(Contract AF 19(628)-325)
(SRI-TR-75; AFCRL-63-131)

Modes of multipactor discharge occurring in a biased gap are described in which secondary emission from only one electrode is required to sustain the discharge. An analysis of these modes, and an experimental corroboration of the theory are presented. It is shown that the lower threshold voltages for the mode in which only one electrode participates are generally lower than for the modes in which both electrodes participate. The application of a d.c. bias to a multipactor gap may therefore lower the RF voltage at which breakdown occurs. Author

N63-17602 General Electric Co. Space Sciences Lab., Philadelphia, Pa.

RADIANCE OF SPECIES IN HIGH TEMPERATURE AIR

R. G. Breene (Physical Studies, Inc.), Maria Nardone, Saydean Zeldin, and T. R. Riethof June 1963 111 p 54 refs
(Contract AF 04(694)-222)
(R63SD3)

The spectral and total radiance of the radiating systems in high-temperature air have been computed for temperatures between 3000° K and 25000° K, and for relative densities (ρ/ρ_0) between 10^{-3} and 10. The total and spectral radiance of equilibrium air over the same temperature and density range has been computed from the composition of equilibrium air and the absorption coefficients of the individual systems. The results are compared with those obtained by previous investigators. Equations approximating the results in regions of low emissivity are derived. Author

N63-17611 Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho

SPERT PROJECT Quarterly Technical Report, Oct.-Dec. 1962

F. Schroeder, ed., J. R. Huffman, and W. E. Nyer AEC National Reactor Testing Station, May 17, 1963 51 p 14 refs
(Contract AT(10-1)-205)
(IDO-16890) OTS: $1.25

A successful integral-core destructive test was performed in the Spert I facility on November 5, 1962, with a highly enriched, plate-type, water-moderated core. A 3.2-msec-period power excursion was initiated by an essentially stepwise addition of 3.5 dollars of reactivity. The excursion was self-limiting, with a peak power of 2.3 Gw and with a nuclear energy release in the burst of 31 Mw-sec. After the nuclear excursion had self-limited and the power had returned to a level of about 5% of the peak value, a sudden pressure rise occurred which disassembled the core and produced widespread damage to associated equipment. Preliminary examination of the data indicates the maximum fuel alloy temperature was slightly in excess of 1200° C, in agreement with calculations based on the measured nuclear energy release. The characteristics of the nuclear burst for the destructive test were in agreement with predictions based on extrapolation of the results of previous nondestructive tests. Preliminary examination of pressure data indicates that the peak pressure in the explosion, which occurred after the nuclear burst, was of the order of several thousand psi and that the rise time of this pressure pulse was significantly less than 1 msec. At the end of the quarter, detailed examination and analysis of the data were in progress, and recovery and cleanup of the reactor area were proceeding. Author

N63-17619 California U., Berkeley. Lawrence Radiation Lab.

ANISOTROPY FACTORS FOR THE DETERMINATION OF TOTAL NEUTRON YIELD FROM THE D(d,n)He^3 AND T(d,n)He^4 REACTIONS

Lawrence Ruby and Richard B. Crawford Apr. 9, 1963 17 p 6 refs
(Contract W-7405-eng-48)
(UCRL-10752, Suppl.) OTS: $0.50

Tables have been computed of the anisotropy factor, R, which is useful in determining, by the associated particle method, the total neutron field produced in the reactions T(d, n)He^4 and D(d, n)He^3. The range of incident deuteron energy covered is 25 to 500 Kev, at associated particle colatitude angles of 90 to 180 deg. Thick-and thin-target cases have been treated. For the T(d, n)He^4 reaction, the total neutrons produced per alpha particle incident on the detector is given by the relation, $N = (4\pi/\Delta\Omega)R$. In the case of the D(d, n)He^3 reaction, it is more convenient to detect the protons produced in the competing reaction D(d, p)T. The total neutrons per proton incident on the detector is then given by $N = (4\pi/\Delta\Omega)R\,(Y_{d,\,n}/Y_{d,\,p})$, where $(Y_{d,\,n}/Y_{d,\,p})$ is the ratio of total neutrons to total protons produced. Tables of this ratio, of R, and of their product are given. Author

N63-17628 Feltman Research Labs., Picatinny Arsenal, Dover, N.J.

RANGE-ENERGY RELATIONS FOR PROTONS AND ALPHA PARTICLES IN VARIOUS EXPLOSIVES

Joseph Cerny, Maurice S. Kirshenbaum, and Roger C. Nichols May 1963 21 p 14 refs
(PA-TR-3070)

Differential energy loss (Mev/mg/cm^2) and range data have been calculated for low- and medium-energy protons and alpha particles in the following eight explosives: RDX (cyclotrimethylene trinitramine), HMX (cyclotetramethylene tetranitramine), TNT (2,4,6-trinitrotoluene), PETN (pentaerythritol tetranitrate), tetryl (2,4,6-trinitrophenyl methyl nitramine), lead styphnate, mercury fulminate, and lead azide. The well-known Bethe theory was followed in establishing the proton ranges. Experimental proton differential energy loss data and theoretical computations were used to establish atomic stopping number versus energy curves for the elements hydrogen, carbon, nitrogen, oxygen, and lead between 20 Kev and 25 Mev. From these curves, molecular stopping numbers were calculated. The alpha-particle ranges were obtained from the established proton ranges. Author

N63-17641 Lockheed Missiles and Space Co., Sunnyvale, Calif.
ELECTROMAGNETIC INTERFERENCE: AN ANNOTATED BIBLIOGRAPHY
P. R. Stromer, comp. Nov. 1962 120 p 252 refs
(SB-62-44; Rept. 3-35-62-7)

This bibliography up-dates and supplements the Bibliography on Radio-Frequency Interference by C. E. Blakely, *et al.* in the IRE Transactions on Radio-Frequency Interference, vol. RFI-4, no. 1, Feb. 1962. Natural radio noise, atmospherics, etc., have been limited to those references relating to space-communications interference. Author

N63-17647 Naval Weapons Lab. Computation and Analysis Lab., Dahlgren, Va.
ACOUSTIC RAYS IN AN OCEAN WITH HEAT SOURCE OR THERMAL MIXING ZONE
Hans J. Lugt and Peter Uginčius Mar. 1963 44 p 8 refs
(NWL-1854)

The eikonal equation of ray acoustics is discussed for the general case, with the index of refraction a function of the three space coordinates. Two examples illustrating the influences of a two-dimensional heat source and a thermal mixing zone on the acoustic-ray paths are presented. Numerical results show that for long-range acoustical-ray tracing, inhomogeneities of the ocean in the horizontal plane can cause refraction effects, which are not negligible in comparison with effects in the vertical direction. Rays, which travel in the vicinity of a heat source, can be refracted as much as 6°. Thermal mixing zones can increase the range of shadow zones near the ocean surface up to 50%. Even new shadow zones can be formed. Author

N63-17690 Bureau of Mines, Washington, D.C.
LOW-TEMPERATURE HEAT CAPACITIES AND ENTROPIES AT 298.15°K OF THE SESQUIOXIDES OF SCANDIUM AND CERIUM
W. W. Weller and E. G. King 1963 10 p refs
(BM-RI-6245)

Low-temperature heat capacities of scandium sesquioxide (Sc_2O_3) and a mixture of cerium sesquioxide (Ce_2O_3) and cerium dioxide (CeO_2) were measured over the temperature range from 50° to 298° K. The entropy of scandium sesquioxide at 298.15° K was evaluated directly as $S^{\circ}_{298.15} = 18.4 \pm 0.1$ cal/deg mole. That of cerium sesquioxide was extracted by combining the heat-capacity data for the mixture with those for pure cerium dioxide; the result was $S^{\circ}_{298.15} = 36.0 \pm 1.0$ cal/deg mole. Author

N63-17696 Columbia U., New York, N.Y.
SEMINAR ON CONTINUUM MECHANICS ARRANGED AS A COURSE OF TEN LECTURES ON THE PRINCIPLES OF CONTINUUM MECHANICS AS SEEN IN THE LIGHT OF A GENERAL THEORY OF TRANSFORMATIONS
Karl Weissenberg Mar. 1963 191 p 18 refs
(Contract Nonr-266(78))
(Tech. Rept. 18)

Advances that were made in continuum mechanics when it was extended from the classical treatment of infinitesimally small deformations to a treatment of unlimited magnitude are discussed. The invariant combinations as shown by the transformation theory are important in continuum mechanics because they provide the basic formulation for all the various theoretical concepts, laws and principles, as well as for the design of instrumentation used in experiments. The principles of kinematics treats the preservation of continuity and the superposition of movements and the resolution into rigid and deformatory components. In dynamics, consideration is given to the different concepts of forces (Newton, Lagrange, Einstein) and the different types (mass and traction) all of which can be distinguished by their different transformation properties. Principles of mechanical properties of continuous media relate and explain: instrumentation for the measurement of mechanical properties, the scalar equation of state (thermodynamics of energy transformations), the correlation of strains and stresses (anisotropic and similitude), the tensorial equation of state deduced by an analytical procedure, and the tensorial equation of state deduced by generalization. N.E.A.

N63-17731 Uppsala U. Quantum Chemistry Group for Research in Atomic, Molecular and Solid-State Theory (Sweden)
ORBITAL THEORIES OF ELECTRONIC STRUCTURE Technical Note
William H. Adams May 1, 1962 42 p 37 refs
(Contract AF 61(052)-351)
(TN-76; ARL-62-400)

It is shown that in the Hartree—Fock approximation there exists a uniquely defined Hermitian potential which describes the interaction of a model subgroup of electrons with the rest of the system. This potential can be divided into two parts. The first part is the difference between the Hartree—Fock Hamiltonian for the system and the model Hamiltonian. The second part is a nonlocal potential which cancels (screens) some of the first part. The essential point in the derivation is the choice of definition for model orbitals in the system. The only condition that must be satisfied by the occupied orbitals of the system is that they be linearly independent. It is also shown that there exist equations describing the best orbitals to use in a calculation by a linear combination of atomic orbitals method. As a concrete example, the LiH molecule has been treated numerically. Indication is given of how the pseudopotential form of the orthogonalized plane wave method may be derived. Author

N63-17772 European Atomic Energy Community, Brussels (Belgium)
TABLES OF CROSS-SECTIONS OF NUCLEAR REACTIONS WITH NEUTRONS IN THE 14-15 MeV ENERGY RANGE
H. Neuert and H. Pollehn (Hamburg U.) Apr. 1963 159 p 167 refs
(Contract Euratom-010-62-6-GEE-D)
(EUR 122.e) Available from Belgian American Bank and Trust Co., New York Account No. 121.86: 250 Belg. Fr.

During the last few years many measurements of nuclear reactions with neutrons (n, 2n), (n, p), (n, np), (n, d), (n,He^3), (n, t), (n, α) and (n,nα) in the energy range E_n = 14 to 15 Mev have been carried out, so that a compilation of the cross sections of these reactions seemed to be of general value. Thus, these tables of cross sections will give a general picture of the measured values available, provide a basis for special theoretical considerations, and in some cases point up the urgency of making further investigations on more precise measurements in this field. Author

N63-17773 Brookhaven National Lab. Sigma Center, Upton, N.Y.

ANGULAR DISTRIBUTIONS IN NEUTRON-INDUCED REACTIONS. VOLUME I, Z = 1 TO 22

Murrey D. Goldberg, Victoria M. May, and John R. Stehn Oct. 1962 383 p refs

(Supported by AEC)

(BNL-400, Vol. I, 2d Ed.) OTS: $8.50 for vols. I and II

This report is a compilation of experimental observations available in October 1962 on the angular distribution of scattered neutrons and of other products of reaction of fast neutrons with nuclei. Data on the elastically scattered neutrons predominates, but there are many distributions given for inelastically scattered neutrons. Some distributions for charged particles and for gamma rays associated with inelastic neutron scattering are also presented. N.E.A.

N63-17776 Texas A. and M. Research Foundation, College Station

ELECTRONIC ABSORPTION SPECTRA OF SIMPLE MOLECULES Final Report

Washington, AFOSR, General Physics Div., Mar. 1963 86 p 74 refs

(Contract AF 49(638)-593)

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N63-17777 Texas A. and M. Research Foundation, College Station

THE FRANCK-CONDON PRINCIPLE AND THE STRUCTURES OF EXCITED ELECTRONIC STATES OF MOLECULES

J. B. Coon, R. E. De Wames, and C. M. Loyd *In its* Electronic Absorption Spectra of Simple Molecules, Mar. 1963 p 1–15 28 refs Repr. from J. Mol. Spectr., v. 8, no. 4, Apr. 1962 p 285–299 (See N63-17776 16-23)

(Contract AF 49(638)-593)

An approximate method is described for quantitatively applying the Franck–Condon principle to the problem of determining the structure of an excited electronic state of a simple polyatomic molecule. The method is applicable to an electronic transition for which both electronic states have structures of the same symmetry. Necessary information includes the geometrical structure and the totally symmetrical frequencies of the ground state, as well as the vibrational analysis of a vibronic band system and the resulting information about the totally symmetrical frequencies of the excited state. The relative intensities of a few selected vibronic bands must be measured. One-dimensional Condon overlap integrals for these bands are expressed in terms of parameters which depend on the change of the geometrical structure with the electronic transition. A comparison of the squares of the overlap integrals with the band intensities permits the evaluation of the geometrical parameters. In an initial calculation, the normal coordinates of the excited state are assumed to be parallel to those known for the ground state. The approximate excited state structure calculated on this basis is used to determine more exact normal coordinates of the excited state. A final calculation based on these coordinates yields an improved excited state structure. The structures of one excited state of ClO_2 and of two excited states of SO_2 are determined. Author

N63-17778 Texas A. and M. Research Foundation, College Station

THE STRUCTURE OF BENZENE IN THE EXCITED ELECTRONIC STATE $^1B_{2u}$

R. D. Mc Kenzie, I. W. Watkins, and J. B. Coon *In its* Electronic Absorption Spectra of Simple Molecules Mar. 1963 p 16–26 8 refs (See N63-17776 16-23)

The geometrical structure of benzene in the excited electronic state, $^1B_{2u}$, is determined using a method based on the Franck–Condon principle. Necessary information includes the ground-state geometrical structure, the totally symmetrical vibrational frequencies of both the ground and excited state, and the relative intensities of a few selected vibronic bands of the 2600 Å band system. Of the four excited-state structures consistent with the observed intensities, the structure specified by $r(C\text{-}H) = 1.076$ Å and $r(C\text{-}C) = 1.434$ Å was chosen. This corresponds to a decrease of 0.008 Å in the C-H distance and an increase of 0.037 Å in the C-C distance. This choice is consistent with the fact that the C-H stretching frequency ν_1 increases in the excited state, while the C-C stretching frequency ν_2 decreases. The corresponding change in the rotational constant is $\Delta B = -0.0086$ cm^{-1}, which compares well with the value $\Delta B = -0.0083$ cm^{-1}, obtained from the rotational structure. Author

N63-17779 Texas A. and M. Research Foundation, College Station

A DOUBLE-MINIMUM POTENTIAL FUNCTION WITH APPLICATION TO NH_3 AND ND_3

J. B. Coon, N. W. Naugle, J. R. Henderson, and R. D. Mc Kenzie *In its* Electronic Absorption Spectra of Simple Molecules, Mar. 1963 p 27–55 20 refs (See N63-17776 16-23)

A three-parameter double-minimum potential function is expressed in a dimensionless form. The eigenvalues and eigenfunctions have been calculated for 360 different sets of dimensionless parameters; however, only the eigenvalues are included in the present paper. If three of the levels of a double-minimum potential of a molecule are spectroscopically observed, these tables permit the determination of the barrier height and the distance between minima. Ammonia is discussed as an illustration. Author

N63-17780 Texas A. and M. Research Foundation, College Station

EVIDENCE FOR A DOUBLE-MINIMUM POTENTIAL IN AN EXCITED STATE OF ClO_2

J. B. Coon, F. A. Cesani, and C. M. Loyd *In its* Electronic Absorption of Simple Molecules Mar. 1963 p 56 Submitted for Publication (See N63-17776 16-23)

Evidence is presented which indicates the existence of a double-minimum potential in the antisymmetrical vibrational coordinate of an excited electronic state of ClO_2. A previously reported vibrational analysis of the 3600A absorption system of ClO_2 vapor proposes the excited state assignments $2\nu_3' = (1^+ - 0^+) = 1559\ cm^{-1}$ and $(4\nu_3' - 2\nu_3') = (2^+ - 1^+) = 1640.5\ cm^{-1}$. In the present work, a two-parameter double-minimum potential function is adjusted to fit these levels of the Q_3' mode. The resulting function has a barrier of 2520 cm^{-1} and, at each potential minimum, one bond is 0.065A shorter and one bond is 0.065A longer than the average bond of 1.620A. A Franck–Condon calculation, based on the vibrational wave functions of the double-minimum potential, yields the intensities of vibronic bands involving $\Delta v_3 = 2$ in approximate agreement with observed intensities. A harmonic potential explains only two percent of the observed intensities. For both of the intervals $(1^+ - 0^+)$ and $(2^+ - 1^+)$, the observed isotope shift is about two-thirds of that expected for a harmonic potential. Such a small shift occurs for plus intervals below the barrier of a double-minimum potential. This means that a barrier somewhat higher than 2520 cm^{-1} is indicated by the isotope shift. Author

N63-17781 Texas A. and M. Research Foundation, College Station

"HOT" BANDS OF THE 2000 Å SYSTEM OF NH_3, ND_3 AND NT_3

B. T. Young, J. R. Henderson, B. L. Landrum, and J. B. Coon *In its* Electronic Absorption Spectra of Simple Molecules Mar. 1963 p 57–64 6 refs (See N63-17776 16-23)

The temperature-sensitive bands of NH_3, ND_3, and NT_3 were photographed in the wavelength region between 2129 Å and 2500 Å using a 2-meter grating spectrograph. Each band was found to consist of two maxima. A partial rotational analysis shows that the band origins lie near the violet edge of the maximum toward the red. This point was measured for bands of NH_3 and ND_3. For NT_3, the red edge of the violet maximum was measured. The temperature-sensitive absorption bands of ND_3 were found to contain three similar groups of bands, while those of NH_3 and NT_3 each consist of two similar groups of bands. The intensities of the invidual bands within a group are about the same at 600° C, but the intensities of the first group of bands are about ten times greater than the intensities of the second group of bands, which, in turn, have intensities about ten times greater than the intensities of the third group. C.L.W.

N63-17782 Texas A. and M. Research Foundation, College Station

ROTATIONAL STRUCTURE AND INTENSITY ENVELOPES OF VIBRONIC BANDS OF SULFUR DIOXIDE NEAR 3700 Å

R. K. Russell and J. B. Coon *In its* Electronic Absorption Spectra of Simple Molecules Mar. 1963 p 65–83 12 refs (See N63-17776 16-23)

Partially resolved rotational structure of two bands of the 3700A absorption system of SO_2 vapor has been investigated. The rotational constants, $\Delta(A-\bar{B}) = 0.310$ and $\Delta\bar{B} = -0.03$, are obtained for the $(000)' \leftarrow (000)''$ transition. In view of the known geometrical structure for the ground electronic state, these constants lead to r = 1.489A and $2\alpha = 125° 58'$ for the excited electronic state. The bands are shown to have perpendicular polarization. Theoretical intensity envelopes, from calculations by the IBM-704 computer, aided in making the analysis. Author

N63-17907 Linde Co. Div. of Union Carbide Corp., Tonawanda, N.Y.

ADVANCES IN CRYOGENIC TECHNOLOGY

C. R. Lindquist Mar. 1, 1963 9 p
(Contract AF 33(657)-10248)

Progress in developing Super Insulation concepts for space vehicle applications is reported, as well as advances in the production and utilization of solid hydrogen. Super Insulation, consisting of alternate layers of metallic foil radiation shields and fiber spacers maintained in a vacuum by a rigid casing, has been used in ground-based applications by providing a rigid casing to prevent compression of the evacuated insulation. Because of possibility of using a flexible vacuum casing over the insulation for space applications on the assumption that the insulation will recover its optimum performance in the vacuum of space, a small stainless steel tank has been Super Insulated and encased in plastic. Tests indicate a satisfactory overall vacuum leak rate after flexing of the plastic jacket. Further studies of Super Insulation application techniques to obtain near optimum performance while reducing cost and weight factors are being conducted from both ground-based tankage and space vehicle applications. Results of an engineering study of the commercial production, transfer, and utilization of hydrogen slush indicate that (1) standard liquid hydrogen transfer techniques can be used; (2) vacuum pumping is the most attractive method of slush production at a plant or at a launch facility; (3) either a closed cycle or liquid-addition open cycle refrigeration system would maintain the slush hydrogen fuel in space vehicle storage tanks. M.P.G.

N63-17908 Army Electronics Research and Development Lab., Fort Monmouth, N.J.

INFLUENCE OF A D.C. AND A.C. MAGNETIC FIELD UPON A GAS DISCHARGE LASER

Rudolf G. Buser, Johann J. Kainz, and John J. Sullivan Dec. 1962 22 p 10 refs
(USAELRDL-TR-2322)

The influence of a magnetic field upon a gas discharge laser has been investigated. The magnetic field changes the spatial and energy distribution of the electrons, and therefore influences the light output of the laser. Experiments show that this effect may be useful for adjustment and modulation of the laser emission. Author

N63-17942 Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

ENERGY AVERAGES IN LOOSELY COUPLED VIBRATING SYSTEMS, WITH APPLICATIONS TO NOISE REDUCTION

Ewald Eichler [1962] 43 p 13 refs Submitted for Publication
(NASA Contract NASr-47)
(NASA CR-50448) OTS: $4.60 ph, $1.49 mf

Vibrations of complex dynamical systems are treated in terms of energy quantities, neglecting details of structure and excitation. Relations between the average energies in loosely and conservatively coupled systems are obtained in terms of internal losses and coupling losses. It is shown that the products of modal density and coupling loss factor are the same for each pair of subsystems. The general theory is applied to study the noise reduction of a rectangular box, and experimental results are compared with theoretical predictions with generally good agreement. The transmission behavior of a box at a given frequency is shown to depend on the relation of this frequency to the lowest mechanical and acoustical resonance frequencies and the critical frequency of the walls. Theory and experiment show that near the lowest mechanical resonances the pressure in the box may considerably exceed that in the incident sound field. Author

N63-17947 Los Alamos Scientific Lab., N. Mex.
LENS DESIGNING TECHNIQUE WITH THE 1962 LASL CODE FOR THE IBM 7090
Berlyn Brixner June 5, 1963 46 p 8 refs
(Contract W-7405-eng-36)
(LA-2877) OTS: $1.25

This report is a detailed instruction manual for users of the 1962 LASL lens-design code, which is a general-purpose computing program for the evaluation and automatic design of optical lens and/or mirror systems with surfaces generated by conic sections. Described in relation to the program are IBM-7090 machine operations, prescription parameters, ray-tracing parameters, weights on lens performance, lens-parameter substitutions, increments to lens parameters, designing instructions, and parameter interactions. The sample calculation for a Lister-type lens is given in great detail. The general procedure used to design a special-purpose zoom lens is given, along with the final lens prescription and the performance characteristics. Author

N63-17957 California U., La Jolla
A CLASS OF ENERGY LEVELS FOR THE HEISENBERG LINEAR CHAIN. I
Robert B. Griffiths [1962] 38 p refs
(Contract Nonr-2216(11))
(Tech. Rept. 13)

The highest and lowest energies as a function of the total spin are computed for the class of "unbound" states in the Bethe formalism for the linear chain of spin 1/2 atoms with a Heisenberg exchange interaction between nearest neighbors. In addition, the magnetization as a function of magnetic field is calculated in the limit of zero temperature for an infinite antiferromagnetic chain. Author

N63-17960 Aerojet-General Nucleonics, San Ramon, Calif.
ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM Quarterly Progress Report, 1 Jan.-31 Mar. 1963
May 15, 1963 64 p refs
(Contract AT(10-1)-880)
(IDO-28607) OTS: $1.50

The scheduled modification of the ML-1 powerplant was completed and the plant was operated continuously for 101.3 hr, between 26 February and 4 March 1963. The maximum reactor power was 3.2 Mw(t) and the maximum shaft output power was 252 kw. The TCS 670A failed during open cycle testing because of insufficient clearances in the turbine. The development testing of the alternator was essentially completed; the alternator will deliver 400 kw with a 45 KVAR per phase external capacitance. Start motor development was completed. Author

N63-17963 Uppsala U. Quantum Chemistry Group for Research in Atomic, Molecular and Solid-State Theory (Sweden)
CORRELATION EFFECTS IN THE ALTERNANT MOLECULAR ORBITAL APPROXIMATION Technical Note
William H. Adams Nov. 15, 1962 11 p 9 refs
(Contract AF 61(052)-351)
(Tech. Note 89; ARL-63-128)

Examination of the two-electron density matrix in the alternant molecular orbital approximation for a large system in a singlet state, reveals that there are both short, and long-range correlations between the electrons of opposite spin. There is also a long-range correlation between electronics of the same spin. These correlations are not found when the wave function for the system is approximated by a single determinant of alternant molecular orbitals. Author

N63-17964 Uppsala U. Quantum Chemistry Group for Research in Atomic, Molecular and Solid-State Theory (Sweden)
SPIN COMPONENT ANALYSIS OF SINGLE DETERMINANT WAVE FUNCTIONS Technical Note
Fukashi Sasaki and Kimio Ohno Nov. 30, 1962 31 p 3 refs
(Contract AF 61(052)-351)
(Tech. Note 90; ARL-63-129)

Spin components involved in a single Slater determinant were analyzed. Behavior of the components for a system of large number of particles is discussed. Author

N63-17965 Uppsala U. Quantum Chemistry Group for Research in Atomic, Molecular and Solid-State Theory (Sweden)
SIMPLE MOLECULAR ORBITAL CALCULATIONS ON THE ELECTRONIC STRUCTURE OF IRON-PORPHYRIN COMPLEXES Technical Note
Kimio Ohno, Yukito Tanabe, and Fukashi Sasaki Dec. 1, 1962 32 p 14 refs
(Contract AF 61(052)-351)
(Tech. Note 92; ARL 63-130)

The simple Hückel method was first applied to the electronic structure of the iron-porphyrin complexes by Pullman *et al.* In this paper, their work is extended to include (a) the effect of a dipole or a point charge placed at the sixth coordination position, and (b) the effect of a nitrogen atom placed at the fifth coordination position. A set of new parameter values is used, whose estimation is made by directing special attention to their dependence on the charge distribution among the atoms. The resulting charge distribution for ferro-porphyrin seems to be reasonable. The fact that the position of the Soret peak is insensitive to the sixth ligand can be understood from the resulting orbital energy levels. Author

N63-17966 New York U., N.Y.
POSSIBLE NEW ATOMIC RESONANCES
S. Lundqvist (Chalmers U. of Tech.) and W. Brandt Repr. from Phys. Letters, v. 4, no. 1, Mar. 1, 1963 p 47-48 3 refs
(NASA Grant NsG-169-61)
(NASA CR-50345)

Equations are presented to support the theoretical evidence for the possibility of the occurrences of new resonances in atoms, that are different in kind from single-particle excitations. These resonances mark the coherent response of an atom as a whole. If this preliminary calculation which is made for a simple statistical model applies to real atoms, it can be concluded that new atomic resonances may appear over a more or less extended intermediate range of atomic frequencies. I.v.L.

N63-18001 Atomic Power Development Associates, Inc., Detroit, Mich.
SODIUM HEATED STEAM GENERATOR SUMMARY
J. Morabito, ed. AEC. Div. of Tech. Inform., Sept. 19, 1962 75 p refs
(Contract AT(11-1)-865)
(TID-18072) OTS: $1.75

Current data and information concerning sodium-heated steam generators are summarized. This information should be of specific interest to possible fabricators of sodium-heated steam generators and of general interest to persons concerned with sodium-cooled reactors and equipment. Both plant size and model steam generators are presented. The plant units represent those intended for use in all unclassified sodium-cooled reactor projects in the U.S. The models are typical of units tested to acquire design information and to test prototypes during the development of some of the plant-sized units. I.v.L.

N63-18009 Western Ontario U. Molecular Excitation Group, London (Canada)
TRANSITION PROBABILITIES OF MOLECULAR BAND SYSTEMS. XXII: FRANCK-CONDON FACTORS TO HIGH VIBRATIONAL QUANTUM NUMBERS III: VACUUM ULTRA VIOLET TRANSITIONS Scientific Report Nos. 3, 7
R. W. Nicholls June 1, 1962 30 p 12 refs
(Grant AF-AFOSR-61-88; Contracts Nonr-2895(00) and AF 49(638)-640)

Franck–Condon factor $q_{v'v''} = |\int \psi_{v'} \psi_{v''} dr|^2$ arrays calculated to high vibrational quantum numbers, on the assumption of a Morse model for the molecular potentials, are presented for vacuum ultraviolet transitions, and for excitation transitions. Author

N63-18010 Atomics International, Canoga Park, Calif.
AEC UNCLASSIFIED PROGRAMS – FISCAL YEAR 1962 Annual Technical Progress Report
Nov. 15, 1962 491 p 137 refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-7400) OTS: $6.00

Progress is reported in the following areas of reactor research: (1) advanced sodium-cooled reactors, (2) Hallam nuclear power facility research and development, (3) advanced organic moderated reactors, (4) prototype organic power reactor, (5) reactor safety, (6) separations chemistry (low-decomposition repossessing of refractory uranium fuels), and (7) nuclear characteristics of reactor lattices and the behavior of neutrons in reactor materials emphasizing the general aspects of reactor physics. N.E.A.

N63-18011 Lockheed Missile and Space Co., Sunnyvale, Calif.
ELECTROLUMINESCENCE: AN ANNOTATED BIBLIOGRAPHY
Peter R. Stromer, comp. June 1963 123 p 263 refs
(Special Bibliography SB-63-6; Rept. 6-90-63-6)

The recent literature of carrier injection (d.c.) and intrinsic (a.c.) electroluminescence has been reviewed. Electroluminescence is defined as the excitation of a phosphor by an electric field whereby the electrical energy is converted to visible radiation. Other forms of energy such as photons, cathode rays, X-rays, etc., give rise to photoluminescence, cathodoluminescence, and X-ray luminescence, respectively. References to these other forms of luminescence have been included only in those instances where they have been studied in combination with electroluminescence. Author

N63-18015 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NONADIABATIC THEORY OF ELECTRON-HYDROGEN SCATTERING, PART II
A. Temkin and E. Sullivan Washington, NASA July 1963 23 p 14 refs
(NASA TN D-1702) OTS: $0.75

The triplet S-wave electron-atomic hydrogen elastic scattering phase shifts are recalculated by a previously introduced nonadiabatic theory. The previous calculation has been improved in a number of respects, the most important of which is the use of a noniterative technique for numerically solving the partial differential equations. (This technique is expected to be useful for a large class of linear second-order elliptic partial differential equations.) Phase shifts are computed to better than four significant figures. The results are quite close to the variational results of Schwartz but are, on the whole, somewhat larger. The deviations are considered significant, and the various approaches are discussed; specifically, our triplet scattering length (in Bohr radii) is $a_t = 1.7683$. Author

N63-18020 General Dynamics Corp. John Jay Hopkins Lab. for Pure and Applied Science, San Diego, Calif.
EXPERIMENTAL TECHNIQUES FOR ACTIVATION MEASUREMENT OF RESONANCE INTEGRALS
M. K. Drake et al Jan. 21, 1963 35 p 8 refs
(Contract AT(04-3)-314)
(GA-3125) OTS: $0.75

Techniques and methods are described for the quantitative measurement of the resonance absorption of thorium and other materials in both a reactor spectrum and a 1/E spectrum. The reactor spectrum of interest is that which will exist in the Peach Bottom High Temperature Gas-cooled Reactor (HTGR). In this reactor, the thorium and the uranium are distributed in part of the graphite of the fuel element. The thorium- and uranium-containing region is an annulus of about one-fourth the volume of the fuel element, having an outer graphite sleeve and an inner graphite cylinder (spine). The vanadium subtraction technique was developed for determining resonance absorption. This technique is an activation method which does not require the use of cadmium-covered foils. The resonance capture rate of the material of interest is measured relative to that in gold, which is a standard of known value. Measurement of the activation rate for three separate detectors in each of two neutron spectra is required for this method. The two neutron spectra are those for which the resonance reaction rate is desired. A Maxwellian spectra is also needed. C.L.W.

N63-18021 Oak Ridge National Lab., Tenn.
MODELS FOR FISSION-GAS RELEASE FROM COATED FUEL PARTICLES
John W. Prados and James L. Scott June 20, 1963 62 p refs
(Contract W-7405-eng-26)
(ORNL-3421) OTS: $1.50

Mathematical relations are presented for estimating the release fractions of gaseous fission products from coated fuel particles and fuel elements containing them. The relations are based on simplified models of the release process, with particular emphasis on the following mechanisms: (a) recoil, (b) diffusion from fuel, (c) diffusion through particle coating, and (d) diffusion through fuel-element matrix. The characteristics of fission-gas release by these mechanisms, acting singly and in combination, are considered, and the application of the theoretical relations to experiment planning and interpretation is discussed. Special attention is given to methods for analysis of data from continuous, in-pile (sweep capsule) release experiments and neutron-activation release experiments. Author

N63-18024 Sheffield U. (Gt. Brit.)
ELECTRON CORRELATION IN METALS
W. Jones and N. H. March Wright-Patterson AFB, Ohio, Aeronautical Research Labs., May 1963 76 p 17 refs
(Contract AF 61(052)-317)
(ARL-63-87)

The first- and second-order density matrices for a uniform electron gas are discussed in the limiting cases of weak coupling (usual gas parameter $r_s \rightarrow 0$) and strong coupling ($r_s \rightarrow \infty$). Attention is focused on the important pair-distribution function and on the momentum distribution. Variational forms of second-order density matrices are discussed, and the Euler equations are obtained for one possible scheme based on localized orbitals. Some progress on the nonuniform gas is briefly reported. Author

N63-18027 Argonne National Lab., Ill.
REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, MAY 1963
Albert V. Crewe June 15, 1963 75 p refs
(Contract W-31-109-eng-38)
(ANL-6739)

This review includes: (1) boiling water reactors; (2) liquid metal-cooled reactors; (3) general reactor technology—applied nuclear physics, reactor fuels and materials development, reactor components development, heat engineering, and chemical separations; (4) advanced systems research and development—the Argonne advanced research reactor and magnetohydrodynamics; and (5) nuclear safety—thermal reactor safety studies, fast reactor safety studies, and the transient reactor test facility. I.v.L.

N63-18048 General Dynamics Corp. General Atomic Div., San Diego, Calif.
INVESTIGATIONS OF CARBIDES AS CATHODES FOR THERMIONIC SPACE REACTORS Quarterly Progress Report for the Period Ending Feb. 28, 1962
A. F. Weinberg, R. G. Hudson, B. Siefner, and L. Yang [1962] 56 p 5 refs
(NASA Contract NAS5-1253)
(GA-3007) OTS: $5.60 ph, $1.88 mf

The rate of weight loss for a specimen of nominal composition 90 mol-% UC–10 mol-% ZrC was found to be 1.15 × 10^{-5} mg/cm^2/sec at 2073° K. In contrast to results obtained for a similar specimen at 2300° K, the rate of weight loss remains constant with exposure time, and no surface uranium depletion is observed. Studies of the compatibility of tungsten and uranium monocarbide to temperatures as high as 2000° C indicate that this combination of materials shows great promise as a nuclear-heated thermionic cathode. The kinetics of the interaction between mixtures of UC_2-UC and four refractory metals, niobium, tantalum, tungsten, and molybdenum, have been further defined at 1800° C, and studies of these materials have been extended to 1200° C. Electron-microprobe analyses of refractory-metal specimens which had been placed in contact with UZrC(6.0 mol-% U–45.8 mol-% Zr–48.2 mol-% C) at 1800° C show that uranium and zirconium penetrate deeply into niobium and tantalum in a period of 50 hr, but molybdenum and tungsten are less affected. Measurements of the electrical resistivities of uranium-carbon alloys in the composition range from UC to UC_2 have been completed at temperatures to 2400° K. Author

N63-18070 Rochester U., N.Y.
AN INVESTIGATION ON THE MULTIPLE COULOMB SCATTERING IN NUCLEAR RESEARCH EMULSIONS
C. Dahanayake and P. J. Lavakare June 12, 1963 23 p 10 refs
(Contract AT(30-1)-875; Grant AF-AFOSR-62-32)
(NYO-10271)

A stack of Kodak emulsions, exposed to 6.2-Bev proton beam, has been used to study the behavior of spurious scattering in these emulsions. The effect of higher order differences has also been considered. A detailed study of the behavior of the scattering constant as a function of cell length is presented. The results indicate the necessity for a slight modification in the theory of multiple coulomb scattering. Author

N63-18098 Grumman Aircraft Engineering Corp., Bethpage, N.Y.
STRUCTURE REMOVAL WITH EXPLOSIVES (MATERIALS TESTING PHASE)
A. G. Foster Oct. 10, 1962 65 p 3 refs
(ADR-07-13-62.1)

This report describes the second phase (materials testing) of a four-part program for structure removal with explosives. This phase was designed to explore and define material parameters that affect the pressure–time relationship existing in the immediate vicinity of an explosive detonation. Instrumentation and techniques devised earlier have been further refined, and several materials and combinations of materials have been subjected to an intense blast environment. The test results are presented and discussed, and conclusions are drawn. Author

N63-18112 California U. Los Alamos Scientific Lab., N. Mex.
INTEGRAL GAMMA AND NEUTRON MEASUREMENTS ON KIWI B-4A
F. M. Cox et al May 29, 1963 56 p 7 refs
(Contract W-7405-eng-36)
(LA-2885) OTS: $1.50

This report presents data on integral neutron fluxes and neutron rad doses measured on the experimental plans involving criticality of the Kiwi B-4A reactor. Studies included a 1,500 foot freeline, two meridian rings, and an equatorial bar. Neutron fluxes and gamma and neutron rad doses show a good approximation to the inverse square relationship with distance, with air attenuation, along the freeline. The angular distribution of the leakage radiation is highly influenced by the core configuration. The equatorial bar shows the experimentally determined flux in the horizontal plane to be isotropic over the arc of the bar. Gamma to fast neutron-dose ratios varied from about 1 at 62 feet to 1.8 at 900 feet. The ratio of thermal flux to total fast flux varied from 0.6 at 62 feet to 0.4 at 1,500 feet. Author

N63-18126 General Dynamics Corp. General Atomic Div., San Diego, Calif.
INTEGRAL NEUTRON THERMALIZATION Quarterly Progress Report [Oct. 1-Dec. 31, 1962]
J. R. Beyster et al Washington, AEC Div. of Tech. Inform., Feb. 11, 1963 72 p 2 refs
(Contract AT(04-3)-167)
(GA-3853) OTS: $1.75

Neutron thermalization studies are outlined as follows: temperature-dependent neutron spectra, spectra in finite media, spectra in zirconium hydride assemblies, asymptotic and time-dependent spectra, and transport theory. R.C.M.

N63-18146 Rochester U., N.Y.
NUCLEAR INTERACTION OF 900 MEV ALPHA PARTICLES
M. V. K. Appa Rao and P. J. Lavakare June 5, 1963 16 p 5 refs Submitted for Publication
(Contract AF(30-1)-875)
(NYO-10269)

The nuclear interactions of 900 Mev He^4 nuclei in nuclear emulsion are studied. The mean free path for interaction is found to be 17.0 ±0.8 cm. This value, together with values obtained at various energies, shows that the mean free path for nuclear interaction of He^4-nuclei in nuclear emulsion is energy independent. The "in-out" interaction has been studied, and the probability, f_{io}, for such an interaction is found to be 12.2 ± 1.6%. Author

N63-18147 Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

THE ROLE AND LIMITATION OF DAMPING IN THE CONTROL OF VIBRATION AND NOISE

R. H. Lyon May 23, 1963 20 p Presented to the 65th Meeting Acoustical Soc. of America, New York City, May 15–18, 1963
(NASA Contract NASr-47)
(NASA CR-50343) OTS: $1.60 ph, $0.80 mf

In assessing the role and limitations of damping in the control of vibration and noise, the environmental effects of source areas and the loading effects of the medium are considered. Rather than discuss any particular application, the source correlation effects are considered for two extreme cases: (1) excitation by acoustic noise where the correlation lengths are tied directly to the frequencies through the acoustic wavelength, and (2) point excitation, which broadly includes impact, turbulent boundary layer, and rain-on-the-roof noise. The frequency and wavenumber response of panels, the properties of the source, correlation in space and time, and the radiation behavior of the structure are considered to determine whether damping may be expected to be useful in reducing the vibration response and/or the acoustic radiation from the structure. The free and forced response of the structure is studied to determine whether the resulting radiation from the structure would be dominated by the free or forced motion. In addition, simple relations are developed between the frequency, the loss factor, and the mean free path on the structure to determine whether it should be considered as a bounded or unbounded system both from the standpoint of vibratory response and acoustic radiation behavior. M.P.G.

N63-18151 Braddock, Dunn and McDonald, Inc., El Paso, Tex.

NANOSECOND PULSE BREAKDOWN STUDY

Daniel F. Mc Donald and Manfred Walter Apr. 15, 1963 41 p 13 refs
(Contract AF 30(602)-2781)
(RADC-TDR-63-201; BDM-BQ-101)

The theory and most recent experimental work on breakdown under high-power microwave pulses are analyzed. Recommendations are made for further theoretical and experimental investigations to extend this work into the nanosecond region. The feasibility of spectroscopic techniques in the study of discharge growth is considered. It is shown that light emitted during discharge buildup may be of sufficient intensity to allow photometric measurements of the growth rate. Author

N63-18185 Ohio State U. Research Foundation. Antenna Lab., Columbus

HORIZONTAL POLARIZATION IN GEODESIC LENSES

Interim Engineering Report

C. E. Ryan, Jr., and R. C. Rudduck Mar. 20, 1963 29 p 3 refs
(Contract AF 33(657)-7829)
(Rept. 1394-8)

Horizontal polarization for wide-band operation in geodesic lenses was studied. A horizontally polarized, geodesic, beam elevation positioning lens utilizing the TE_{01} waveguide mode was designed and tested. It was found that the lens will position either a horizontally polarized or a vertically polarized beam over a range of elevation angles. Since a TE_{01} lens will also support the TEM mode, vertical polarization can be obtained from the same lens. However, for the same feed radius, the respective beam-elevation angles for the two polarizations do not coincide. Through the use of beam-elevation positioning, a method of dual polarization in a single beam may be practical. Author

N63-18196 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

ATOMIC ENERGY (SELECTED ARTICLES)

Apr. 27, 1962 39 p 20 refs Transl. from Atomnaya Energ. (Moscow), v. 11, no. 6, 1961 p 498-505, 515-521, 522-527
(FTD-TT-62-213/1+2+4)

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N63-18197 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

A STUDY OF THE BR-5 FAST REACTOR (SPATIAL AND ENERGY DISTRIBUTION OF NEUTRONS)

A. I. Leypunskiy et al Aug. 17, 1961 *In its* Atomic Energy (Selected Articles) Apr. 27, 1962 p 1–11 2 refs (See N63-18196 16-23)

The design of a working fast reactor, and its basic experimental equipment is briefly described. The reactor is intended for carrying out technological and physical studies and studies of materials. Its total rated output is 5000 kw. Characteristics are given for the purpose of illustrating the experimental possibilities of the installation as a source of fast and slow neutrons. Also given are the results of a study of the neutron spectrum in the core, the reflector, and the experimental devices (beams, channels, thermal column). The data obtained are compared with the calculated data. Author

N63-18198 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

CRITICAL THERMAL FLOW WITH BOILING WATER IN THE CHANNELS

Z. L. Miropol'skiy and M. Ye. Shitsman Apr. 8, 1961 *In its* Atomic Energy (Selected Articles) Apr. 27, 1962 p 12–24 14 refs (See N63-18196 16-23)

Processing is given of the experimental data of various authors on critical thermal flows, using dimensionless criteria. Theoretical recommendations are made to determine critical thermal flows with movement of water-vapor mixtures, and water subheated to a saturation temperature in tubes, annular, and plane slit channels. Author

N63-18199 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

THE USE OF RESONANCE INDICATORS IN STUDYING NEUTRON SPECTRA IN FAST-NEUTRON REACTORS

V. I. Golubev et al Apr. 17, 1961 *In its* Atomic Energy (Selected Articles) Apr. 27, 1962 p 25–35 4 refs (See N63-18196 16-23)

The possibilities of studying the low-energy portion of the neutron spectrum in reflectors of fast reactors with the aid of resonance activation indicators are discussed. The methods of resonance blocking and "subtraction of the contribution of 1/v" are illustrated by means of measurements of the distribution of resonance-neutron fluxes with energies of 4.9 ev (Au^{197}) and 2.95 Kev (Na^{23}) in the reflectors of the BR-1 and BR-5 reactors. It is shown that, with the aid of a set of the recommended indicators, it is possible to study in sufficient detail the region of the neutron spectrum from one to several thousand electron volts. Author

N63-18209 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
LEAK-RATE TESTING OF THE NASA PLUM BROOK REACTOR CONTAINMENT VESSEL
Edward G. Keshock and Claude E. De Bogdan Washington, NASA, July 1963 34 p 10 refs
(NASA TN D-1731) OTS: $1.00

The leak rate of the 520,000-cubic-foot Plum Brook Reactor containment vessel has been measured by two methods, the absolute-temperature-pressure method and the reference-system method. Both methods are described, and the equations for leakage in each method are investigated in detail. It is analytically determined that thermal-time-lag effects in small diameter reference systems are negligible. The results of three tests in which both methods were employed simultaneously are presented. A distinctive feature of one of the tests was the verification of the accuracy of results by using a known leak rate. Various test experiences are also presented. Author

24 PHYSICS,PLASMA

Includes: fusion; and magnetohydrodynamics.

For related information see: 05 Astronomy and Astrophysics; 23 Physics, General; and 25 Physics, Solid-State.

N63-17481 Princeton U. Plasma Physics Lab., N.J.
APPLICATION OF THE VIRIAL THEOREM TO EQUILIBRIA OF TOROIDAL PLASMAS
Shoichi Yoshikawa Apr. 1963 30 p 18 refs
(Contract AT(30-1)-1238)
(MATT-191)

Necessary conditions for equilibrium of a current-carrying toroidal plasma are derived under the assumption of azimuthal symmetry. It is demonstrated that an azimuthally symmetric toroidal plasma can be in equilibrium only if an additional tranverse magnetic field is present which absorbs the expanding force of the plasma. An expression of parabolic pressure distribution is obtained when the plasma minor radius is much smaller than the major radius. Stability criterion of the plasma ring against displacement is discussed. The weak focusing can be employed to stabilize the plasma ring. Author

N63-17516 Electro-Optical Systems, Inc., Pasadena, Calif.
THE HALL CURRENT PLASMA ACCELERATOR
Gordon L. Cann, Richard W. Ziemer, and Gary L. Marlotte New York, AIAA [1963] 36 p 18 refs Presented at AIAA Electric Propulsion Conf., Colorado Springs, Colo., Mar. 11-13, 1963
(NASA Contract NAS3-2500)
(AIAA Paper 63011) AIAA: $0.50 members, $1.00 nonmembers

A theoretical and experimental investigation is made of the operation of a relatively new type of plasma accelerator—the Hall Current Accelerator. This device employs the radial component of a fringing magnetic field, a Hall induced current, and an axial discharge to obtain the electromagnetic acceleration of a neutral plasma. A theoretical determination is made of the net accelerating force per unit volume exerted upon the plasma. On the basis of a three-particle gas kinetic theory, exact equations for the three components of the accelerating force are derived. The axial force component, which is predominant, is shown to be equivalent to the electrostatic acceleration of the ions, the electrons being "trapped" by the applied magnetic field. It can also be shown to be equivalent to the Lorentz force resulting from the cross product of the Hall induced azimuthal current and the applied radial magnetic field, whence the name Hall current accelerator. The mechanisms by which energy is transferred from the electromagnetic field to the gas is also studied. Hall current accelerators of both cylindrical and annular geometries were built and operated. Tests with the cylindrical geometry showed Hall current acceleration to occur. However, since the radial magnetic field vanishes on the axis of the channel, the current would concentrate along the center line and not be effectively accelerated. An annular geometry accelerator was built with a radius ratio of 2.4 and operated with both argon and helium plasmas. The Hall acceleration was measured under varying conditions of plasma density, magnetic field strength, and accelerator current. Velocity ratios of up to 2.78 were obtained. A correlation of the experimental results with the theory are made and excellent agreement is found. The potentialities of the Hall accelerator are presented which, with further development, appear to be most promising. Author

N63-17553 Princeton U. Plasma Physics Lab., N.J.
THE MULTIPOLAR CUSP MAGNETIC FIELD AND ITS APPLICATION TO THE ADIABATIC COMPRESSION OF PLASMA
Koji Uo Apr. 1963 35 p 1 ref
(Contract AT(30-1)-1238)
(MATT-185)

A magnetic valve which prevents the escape of plasma through the ends of the cylindrical multipolar cusp field is proposed. It is shown that this multipolar cusp field will be useful for preventing the formation of hot plasma produced by ion cyclotron heating in the region close to the wall and providing a plasma of low impurity level. Author

N63-17558 Toronto U. Inst of Aerophysics (Canada)
THE EFFICIENCY OF ENERGY TRANSFER ASSOCIATED WITH MAGNETICALLY DRIVEN SHOCK WAVES IN A TREE TUBE
J. K. Dukowicz Apr. 1963 51 p 22 refs
(Contract AF 49(638)-823)
(UTIA-TN-52; AFOSR 2429)

The energy disposal in a shock tube with magnetically driven shock waves has been studied. The well known T-Tube apparatus was used in the experiment. A technique to measure the energy input has been developed involving the simultaneous measurement of the current and the voltage drop across the tube. Schlieren rotating-drum-camera photographs of the flow provided accurate shock-wave trajectories from which the energy contained in the flow was deduced by the use of strong blast-wave theory. The efficiency of the T-Tube obtained in this way was found to be approximately 20 percent under a variety of conditions. The use of a backstrap did not change the efficiency, but was found to roughly double the amount of energy deposited in the T-Tube. In the range 1 to 10 mm. Hg., no effect of pressure was detected. Author

N63-17590 Princeton U. Plasma Physics Lab., N.J.
A STUDY OF THE STRUCTURE OF PLASMOIDS GENERATED BY AN ELECTRODELESS PLASMA GUN
Daniel R. Wells May 12, 1963 136 p 57 refs
(Contract AT(30-1)-1238)
(MATT-196)

The formation and propagation of plasmoids produced by a cone-shaped electrodeless plasma gun are studied. Plasma produced by conical coil acceleration was observed for two principal modes of operation of the conical coil. In one mode the coil is "crowbarred" so that the current is not allowed to reverse. The plasma stream leaving the accelerator does not appear to rotate. The spheroidal structure formed by the plasma stream entering into the collimating field region also does not appear to rotate and shows no evidence of violent instability. In the second mode of operation, the coil is permitted to ring, and the current reverses several times as the capacitor bank discharges. The plasma leaves the coil as a series of plasma vortex rings which move in a surrounding plasma "mist" that moves with double the velocity of the rings. The rings are followed by rotating filamentary structures (believed to be the residue of a second internal plasma ring formed during the compression). All these structures merge entering on the collimating field and form a single long plasmoid which rotates rapidly. A simple plasmoid model to analyze current flow in plasma is developed. A Hall current theory of plasmoid formation is checked experimentally. N.E.A.

N63-17625 Naval Ordnance Lab., White Oak, Md.
A PROBE FOR ELECTRICAL CONDUCTIVITY MEASUREMENTS IN IONIZED GASES
Lemmuel L. Hill, Theodore Marshall and Benjamin J. Crapo Apr. 1963 22 p 6 refs
(NOLTR-62-186; Ballistics Res. Rept.-83)

A probe technique for measuring the electrical conductivity in a small region of an ionized flow field is described. The technique involves observing the interaction between an ionized gas and a small perturbing RF magnetic field. The probes are basically small coils. Several probes have been dynamically calibrated in a shock tube. A few preliminary measurements were made in the wake of a 4-inch sphere which was subjected to high-speed flight conditions. Author

N63-17635 Utah U. Microwave Devices Lab., Salt Lake City
SPACE-CHARGE WAVES IN A STATIONARY PLASMA
Joseph Chen Lee and C. C. Johnson May 1963 44 p 18 refs
(Grants NSF-G-15017; NSF-GP-843)
(NSF-TR-4)

Propagation of space-charge waves in a stationary plasma is discussed. The modes of propagation in a plasmaguide are electrochemical in nature: the electron density in the plasma column or on its surface is modulated as the wave passes. The space-charge waves are quite different from the modes of the hollow circular waveguide perturbed by a plasma column. They are slow waves and can propagate below the waveguide cutoff. An anode coupler was designed and built for space-charge excitation. A standing-wave pattern resulted from energy reflection from the unterminated end of the plasmaguide, and wavelength measurements were made by a moving probe inserted in a slotted cylindrical waveguide. The forward space-charge waves for both finite and zero static magnetic field cases were observed and their exciting radian frequency-propagation constant diagrams were plotted. When compared with the theoretical curves, it is seen that the electron plasma radian frequency values from the wave measurements are much higher than those from cavity measurements. As the probe was moved along the waveguide, the distances between adjacent peaks and nulls fluctuated, due to variation in electron density and noise oscillations. C.L.W.

N63-17638 Lockheed Missiles and Space Co., Sunnyvale, Calif.
PLASMA PROPULSION: AN ANNOTATED BIBLIOGRAPHY
Robert C. Gex, comp. Apr. 1962 70 p 161 refs
(SB-62-20; Rept. 6-90-62-34)

The scope of this search includes available literature published in the last 5 years on proposed plasma propulsion systems or devices. Emphasis was placed on review articles and reports of experimental work. Author

N63-17659 Ion Physics Corp., Burlington, Mass.
ANALYTIC CONSIDERATIONS RELATED TO THE LEWIS TYPE BOMBARDMENT ION ENGINE
Ira Kohlberg N.Y., American Inst. of Aeron. and Astronautics, Mar. 1963 16 p 9 refs Presented at the AIAA Electric Propulsion Conf., Colorado Springs, Mar. 11–13, 1963
(NASA Contract NAS8-1684)
(AIAA Paper 63030-B-63) AIAA: $0.50 members, $1.00 nonmembers .

An exploratory, theoretical model was developed to determine the regions of weak and strong plasma; and, in addition, was used to predict the radial shape of both plasma density and electrostatic potential. The electron distribution function was calculated for Hg under an assumed weak plasma condition which showed that the electron temperature, T_f, varied as $(E/B)^2$ with estimated values ranging from 250,000° to 400,000° K. Experimental results gave at times a slight increase of T_f with B with measured values in the 60,000° to 90,000° K range. Consequently, based on this variance, we concluded the arc did not operate as a weak plasma. The kinetic model for the arc utilized both a primary electron group and a Maxwellian group which evolved from ionization and elastic slowing down of the primaries. The radial potential, V(r), and plasma density, N(r), were calculated by developing a modification of ambipolar diffusion theory. The results gave $N(r) = N_o J_o(\gamma r)$, and $V(r) = V_o \ln N + \text{constant}$, where γ depends upon a number of operational parameters. It was found that relatively small adjustment in the calculated value of γ could bring the theoretical and experimental N(r)'s into agreement for average plasma densities greater than 10^{11} cm^{-3}. The uncertainties in the measurement of V(r) precluded comparison of this quantity. Author

N63-17675 Michigan U., Ann Arbor
EXISTENCE AND UNIQUENESS THEOREMS FOR THE NEUTRON TRANSPORT EQUATION
K. M. Case and P. F. Zweifel Apr. 1963 36 p 4 refs
(Supported in part by ONR, NAVY, and AEC)

In an attempt to understand the conditions under which the neutron transport equation has solutions, and the properties of those solutions, a number of existence and uniqueness theorems are proved. The properties of the solution are closely related to the boundedness of the source as well as to certain velocity-space integrals of the scattering kernel. Both time-dependent and time-independent equations are considered, as are also the time-dependent and time-independent adjoint equations. Author

N63-17678 Aerospace Corp. Labs. Div., El Segundo, Calif.
ELECTRICAL CHARACTERISTICS OF COUETTE AND STAGNATION BOUNDARY LAYER FLOWS OF WEAKLY IONIZED GASES
Paul M. Chung Oct. 1, 1962 56 p 20 refs
(Contract AF 04(695)-169)
(TDR-169(3230-12)TN-2; SSD-TDR-62-119)

The electrical behavior of weakly ionized compressible gases flowing along a solid boundary is studied. Analysis is made for flows wherein the range of electrical effects is much greater than the mean free path. Exact solutions are obtained by digital computer for Couette flows. A simple method is derived which gives accurate results when the ratio of the viscous layer thickness to Debye shielding length is large. The simple method derived for the Couette flow is extended to stagnation boundary-layer flows for two-dimensional and axisymmetric blunt bodies. The method is shown to be readily usable for plasma diagnostics for a range of test conditions in laboratories. The general effects are discussed of gas-phase recombination and of electron temperatures that are different from the gas temperature with regard to the electrical characteristics of the ionized gas. Author

N63-17681 Aerospace Corp. Aerodynamics and Propulsion Research Lab., El Segundo, Calif.

THE BOUNDARY LAYER OF A CONDUCTING VORTEX FLOW OVER A DISK WITH AN AXIAL MAGNETIC FIELD General Research

W. S. Lewellen and W. S. King Dec. 7, 1962 45 p 19 refs
(ATN-63(9227)-1)

The interaction of the boundary layer, produced by the vortical flow of a viscous, incompressible, electrically conducting fluid over a stationary disk, with a magnetic field that is aligned with the vortex axis, is considered. The relation of this problem to both the magnetohydrodynamic vortex power generator and the hydromagnetic capacitor is discussed. The boundary-layer equations are solved by two approaches. First, a momentum integral technique is used to gain estimates of the flow behavior over a finite disk. Second, conditions necessary for similarity over an infinite disk are investigated, and the equations appropriate to this case are derived. The similarity equations are solved analytically for cases of strong magnetic interaction. The profiles obtained from the similarity solution are used for a discussion of the appropriateness of the approximate profiles assumed in the foregoing momentum integral method. The flow outside of the boundary layer is assumed to be that of a strong vortex in which the streamlines are nearly circular. In such flows, it is shown that the boundary-layer development will, in many cases, be purely hydrodynamical, even when the flow outside the boundary layer is governed by magnetohydrodynamic effects. Author

N63-17742 Jet Propulsion Lab., California Inst. of Tech., Pasadena

FLUX REVERSAL BY NÉEL WALL MOTION

John A. Copeland and Floyd B. Humphrey Apr. 1963 Repr. from J. Appl. Phys., v. 34, no. 4 (Pt. 2), Apr. 1963 p 1211–1212 9 refs
(NASA Contract NAS7-100)

Domain wall motion is expected to be the fundamental flux reversal mechanism for thin permalloy films in the low drive region $H < H_K$. The velocity of a wall when a switching field H is applied is given by $V = G(H - H_O)$, where G is the mobility and H_O is the starting field. For films with thicknesses on the order of a few hundred angstroms, where Néel walls are expected, the mobility is limited by intrinsic damping to a value much smaller than would be expected if only eddy current damping were present. Calculations have been made using a value for the damping constant, $\alpha = .015$, obtained from coherent rotation studies, and the experimental values for the thickness of the wall obtained by Fuchs in order to obtain G as a function of film thickness. The mobility was measured for seven permalloy films ranging from 128 to 495Å thick. The agreement between the calculations and experiment was within 30%, indicating that the value of α for a 100Å film is nearly the same as for thicker films. Author

N63-17765 General Electric Co. Space Sciences Lab., King of Prussia, Pa.

EFFECT OF INDUCED DIPOLE INTERACTION ON THE CROSS SECTION FOR ROTATIONAL EXCITATION BY ELECTRONS

Douglas H. Sampson May 1963 25 p 20 refs
(R63SD43)

A calculation of the inelastic cross section for rotational excitation of homonuclear molecules by impact with slow electrons is performed using the Born approximation. The calculation is similar to that conducted by Gerjouy and Stein except that, in addition to the pure quadrupole interaction, the induced dipole interaction is included. This results in a significant increase in the rotational cross section, particularly for electron energies $\epsilon_a \geq 0.1$ ev. (The increase for N_2 at $\epsilon_a = 0.4$ ev is by about a factor of 2.) This at least partially accounts for the rise in electron energy loss rates usually attributed entirely to the onset of vibrational excitation. The use of the Born approximation would appear to be less accurate for this problem than previously assumed. This results partially because the induced dipole interaction goes as a higher inverse power of r (r^{-4}) than the pure quadrupole interaction; however, it is partially due to the fact that the distortion of the electron wave function by the spherically symmetric part of the potential should also be considered. Author

N63-17895 Yale U. Observatory, New Haven, Conn.

INTERACTION OF RADIATION AND MATTER IN A PLASMA [Interim Technical Report]

Ludwig Oster Wright-Patterson AFB, Ohio, Aeronautical Research Lab., Feb. 1963 21 p 9 refs
(Contract AF 33(657)-7271)
(ARL-63-62)

This report describes a part of a theoretical investigation of the theory of the emission and absorption of radiation from a fully ionized plasma in the presence of a magnetic field. Specifically, the bremsstrahlung radiation and departures from L.T.E. are discussed. Author

N63-17901 Selenia S. p. A., Rome (Italy)

PROPAGATION OF WAVES IN INHOMOGENEOUS MAGNETO-ACTIVE PLASMA COLUMNS Technical Note No. 3

Pietro de Santis Jan. 29, 1963 25 p 7 refs
(Contract AF 61(052)-145)
(AFCRL-63-642)

A preliminary theoretical investigation of the propagation of a quasi-static E mode, in a plasma column with nonuniform electron density distribution in the cross-section, has already been performed in the special case of a density independent ϵ_3/ϵ_1 ratio. Starting from Maxwell's equations, a more general case is considered, where a parabolic distribution has been taken as an analytical model for the electron density profile in the cross section. Electron density is supposed to vanish at a point outside the plasma column; in the limit for the zero point to go to infinity, uniform case equations are obtained. Letting the metal walls move to infinity, or coincide with the plasma boundary, the completely filled waveguide and the plasma column in free-space dispersion curves have been verified. The Ritz variational method is used to minimize the error over the cross section when an approximation function for the field distribution in the plasma is assumed. Author

N63-17919 Avco Corp. Research and Advanced Development Div., Wilmington, Mass.

APPROXIMATE METHOD FOR CALCULATING MAGNETOHYDRODYNAMIC BOUNDARY LAYER AND HEAT TRANSFER OF A SLIGHTLY CONDUCTING FLUID PAST A CYLINDRICAL BODY

Hwachii Lien and Hsuan Yeh (Penn. U.) N.Y., AIAA [1963] 32 p 26 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17-20, 1963
(NASA Grant NsG-316)
(AIAA Paper 63-202) AIAA: $0.50 members, $1.00 non-members

An approximate method for the solution of the laminar magnetohydrodynamic boundary layer and heat transfer has been developed. This method can be applied to the problem of an incompressible flow past an arbitrarily shaped cylindrical body in the presence of a magnetic field normal to the axis of the cylinder. Based on this method, calculations are made for the case of flow around a circular cylinder. First, the velocity and pressure distributions in the inviscid flow (with a magnetic field) is obtained. These results, then, are used to solve the viscous and thermal boundary-layer equations. Detail calculations have been made on the influence of the Reynolds number, Prandtl number, Eckert number, and the magnetic interaction parameter on the point of separation, the boundary-layer thickness, the shear stress at the wall, the velocity and the temperature profiles, and the rate of heat transfer. Author

N63-17950 Avco-Everett Research Lab., Everett, Mass.
MAGNETOHYDRODYNAMIC POWER GENERATION, A BIBLIOGRAPHY
Barbara A. Spence, comp. June 1963 40 p 399 refs
(AMP-110)

N63-17953 Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.
GROWING TRANSVERSE WAVES IN A PLASMA IN A MAGNETIC FIELD
Peter D. Noerdlinger Repr. from Ann. Phys., v. 22, no. 1, Apr. 1963 p 12-53 24 refs
(NASA Grant NsG-96-60)

Instabilities in uniform collisionless plasmas may be relevant to the understanding of several astrophysical and geophysical problems, and to the confinement of plasmas in the laboratory. This paper presents a practicable method for ascertaining the instability of such plasmas in a uniform, steady magnetic field with respect to disturbances propagating along the direction of that field. The method is applied to two examples of plasmas having anisotropic pressure. Author

N63-18022 RAND Corp., Santa Monica, Calif.
THE MOTION OF ELECTRONS IN A RADIOFREQUENCY FIELD
Mary F. Romig June 1963 48 p 19 refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-3364-PR)

The motion of electrons in a radiofrequency field is investigated for a cylindrical geometry and an electromagnetic-field configuration, consisting of a spatially constant axial magnetic field and an azimuthal electric field, which varies linearly with distance from the center of the cylinder. When the motion is collisionless, the equations can be solved analytically to show that stable (time-bounded) motion exists for certain values of the ratio of electron cyclotron frequency to applied field frequency. Confinement of the orbits to a region entirely inside the cylinder is completely assured only for those particles which start from rest; in all other cases the maximum radius of extent depends on initial position and velocity. Collisions are qualitatively accounted for in a crude manner by use of the Langevin equation, which includes a drag force due to collisions in the equations-of-motion. Some numerical examples of the motion are presented for both the collisionless case and the Langevin equation. An approximate solution is obtained for the case with collisions, which adequately describes the mean motion whenever the ratio of collision frequency to field frequency is larger than three. Author

N63-18025 Nihon U. Coll. of Science and Engineering, Tokyo (Japan)
FINITE TRANSIT TIME EFFECT IN THE RADIO-FREQUENCY PROBE
Yoshik H. Ichikawa [1963] 14 p 5 refs
(NUP-63-9)

Experimental studies have shown that when a small amplitude oscillating potential is superimposed on static potential of the Langmuir probe, besides the resonance increase of the direct current at the electron plasma frequency, the rectified increase of the direct current diminishes very rapidly in the high-frequency region of $\omega > \omega_p$. In this paper, the diminishment of the rectified direct current increase is interpreted in terms of the finite transit time effect of electrons which traverse through the sheath region. Author

N63-18055 Case Inst. of Tech., Cleveland, Ohio
RALEIGH'S PROBLEM IN MAGNETOGASDYNAMICS
Pau-Chang Lu (Ph.D. Thesis) 1963 152 p 17 refs
(NSF Grant 19000)

The velocity, temperature, and magnetic-field distributions in a compressible and viscous fluid, both thermally and electrically conducting, induced by the impulsive motion of an infinite flat plate in its own plane are obtained by applying the inner-outer expansion technique of Kaplun, Lagerstrom, and Cole. The problem is first discussed in general terms, without reference to specific wall conditions and conductivity laws. Details are taken up for the limiting case of infinite conductivity, as well as for seeded argon at about 2500° K. This latter case has been made as realistic as possible without complicating the numerical computations too much. The numerical results show the practicability of the technique as applied here, and the qualitative behavior to be expected in similar cases. The importance of treating the orders of magnitude of governing parameters relative to the magnetic Prandtl number is emphasized throughout. Author

N63-18077 Northrop Corp. Northrop Space Labs., Hawthorne, Calif.
EXPERIMENTAL STUDY OF MAGNETOHYDRODYNAMIC DUCT (J × B) TYPE PROPELLANT PROPERTIES Quarterly Progress Report 1, July 1-Sept. 30, 1962
S. T. Demetriades and A. N. Kontaratos [1962] 23 p 5 refs
(Contract AF 33(657)-8901)
(NSL-62-149-2)

Facility improvements are described, and preliminary results of plasma temperature determinations by photographic measurements of the intensity ratio of two spectral lines are discussed and evaluated. Some definitive experiments yielding information of the validity of the momentum-change technique for plasma diagnostics are described, and the results discussed briefly. Author

25 PHYSICS, SOLID-STATE

Includes: semiconductor theory; and masers.

For related information see: 09 Electronics; 23 Physics, General; and 24 Physics, Plasma.

N63-17495 Stanford Research Inst., Menlo Park, Calif.

INVESTIGATION OF SOLID STATE ELECTROLYTE · Final Report

W. J. Fredricks, F. J. Keneshea, D. S. Bloom, and A. B. Scott Feb. 4, 1963 46 p 17 refs
(Contract AF 19(604)-7231)
(AFCRL-63-74)

The investigation reported concerned the role of imperfections in solids, particularly the interactions between various types of chemical defects and between chemical defects and crystal defects in semiconductors. One part of the study was a theoretical analysis of substituents of Group-IV elements in compounds of elements of Groups III and V. In this work, the electrical properties of GaSb with Sn as substituent were calculated from thermodynamic and other considerations. Following this study, an experimental program was undertaken to measure the electrical resistivity and Hall effect of GaSb up to nearly 600° C, and to infuse small amounts of Sn into GaSb under nearly equilibrium conditions. Another part of the investigation concerned the diffusion of Pb^{++} ions in single crystal KCl over the temperature range of 200° to 475° C. In this study radioactive tracers were used, and the constants for the diffusion equation of Pb in KCl were determined. The results support the theory that diffusion occurs by mobile impurity-vacancy complexes. Finally, an extensive literature survey of compounds of elements of the I-VII, II-VI, III-V Groups, and of the Group IV elements was published. Author

N63-17513 Iowa Engineering Experiment Station, Ames

THE EFFECT OF GRAIN BOUNDARIES ON THE PLASTIC DEFORMATION OF SODIUM CHLORIDE Interim Technical Report No. 1, July 1, 1960—Nov. 21, 1962

Stanley A. Long and Thomas D. Mc Gee [1962] 11 p 11 refs
(Contract DA-11-022-ORD-3466)
(AROD-2916-1)

Sodium chloride single crystals were joined at a melt zone with a hot-wire technique to produce bicrystals of controlled crystallographic orientation. The plastic-deformation properties of the bicrystals were measured in bending while observing the birefringence with a petrographic microscope. The birefringence at the boundary was interpreted to indicate that significant deformation across the grain boundaries occurred. The stress required for deformation across the boundary was found to increase with increased angle between crystallographic axes. Twist boundaries were found to be more resistant than tilt boundaries. Behavior was consistent with the dislocation model for grain boundaries. Author

N63-17526 Massachusetts U. Polymer Research Inst., Amherst

A LATTICE MODEL FOR SCATTERING FROM POLYMER FILMS I

Richard S. Stein and Sue N. Stidham Sept. 10, 1962 34 p 8 refs
(Contract Nonr-3357(01))
(ONR-TR-49)

A crystalline polymer is represented by a lattice model in which the correlation in orientation of optic axes of crystallites is represented by assigning four possible orientation directions to lattice cells. These orientation directions are sequentially assigned by computer by making use of some assumed probability rules defining the correlation. An example of a typical 2-dimensional lattice generated in this manner is given for "random-correlation." V_v and H_v scattering patterns are calculated by computer for the lattice. Author

N63-17605 Massachusetts U. Polymer Research Inst., Amherst

THE DETERMINATION OF BIAXIAL ORIENTATION BY X-RAY DIFFRACTOMETRY

C. Richard Desper and Richard S. Stein Sept. 10, 1962 39 p 8 refs
(Contract Nonr-3357(01))
(ONR-TR-51)

The state of biaxial orientation of crystallites of a polycrystalline polymer may be determined by measuring the X-ray diffracted intensity from particular crystal planes (at a fixed Bragg angle) as a function of the azimuthal diffracted angle and of the sample tilt angle. The orientation distribution may be expressed in terms of two-dimensional pole-figure projections or in terms of biaxial orientation functions. Geometric relations governing the determination of such pole-figures are stated, and a computer program is presented for their calculation. Correction factors for absorption, polarization, and incoherent scattering are included. Author

N63-17608 General Telephone and Electronics Labs., Inc., Bayside, N.Y.

DISLOCATION STUDIES IN DIAMOND BY X-RAY DIFFRACTION MICROSCOPY

F. Euler and G. H. Schwuttke Mar. 1963 19 p 22 refs Presented at 20th Pittsburgh Diffraction Conf., 7–9 Nov., 1962
(AFCRL-63-65)

Diamonds of both type I and type IIb have been studied by X-ray diffraction microscopy. Long-range strain fields are the dominating imperfections in the former, and dislocations appear to be closely related to strain centers. The latter show a much higher density of edge dislocations with Burgers vectors in the (111) planes. These studies corroborate the general view that type I diamond is more perfect, but also more strained, and type II close to mosaic and less strained. The new findings are discussed in comparison with the birefringence and X-ray diffraction phenomena observed in types I and II diamond. Author

N63-17609 Johns Hopkins U. Carlyle Barton Lab., Baltimore, Md.

WAVE FUNCTIONS, ENERGIES, AND REDUCED MATRIX ELEMENTS OF THE $5f^3$ CONFIGURATION IN INTERMEDIATE COUPLING

Hannah M. Crosswhite May 1963 35 p 29 refs
(Contract AF 33(756)-11029)
(AF-105)

Since the crystal field can be considered as a perturbation of the free-ion spectra of actinide ions in certain crystals, calculations were made of energy levels and wave functions of the $5f^3$ configuration, which is the ground configuration of U^{3+}, in intermediate coupling for values of $X = \zeta/F_2$ of 7 to 11. Energy levels are given in units of F_2, and wave functions are expressed as linear combinations of Russell–Saunders functions. Hydrogenic and nonhydrogenic approximations are compared. Reduced matrix elements in intermediate coupling are given so that crystal field splittings may be calculated. The splittings of the two lowest levels of U^{3+} in a weak field, with and without J-mixing, are compared. Author

N63-17614 Arizona State U., Tempe

AN INVESTIGATION OF THE ELECTRICAL AND OPTICAL PROPERTIES OF SEMICONDUCTORS AND INSULATORS WHICH HAVE BEEN IRRADIATED BY FAST NEUTRONS Final Report

R. Jensen and L. Stubbe Jan. 1963 30 p 18 refs
(Contract AT(11-1)-715)
(TID-17912)

Colloid absorption bands and predicted plasma wavelengths are given for calcium fluoride, sodium fluoride, and cesium bromide crystals. Also, the effect of pile irradiation on the electrical resistivity of semiconducting titanium dioxide, in its rutile crystal modification, was investigated. The predicted plasma wavelengths have been calculated for two valence electrons per atom for calcium particles in calcium fluoride and one valence electron per atom for sodium particles in sodium fluoride and for cesium particles in cesium bromide; with each crystal, one of the characteristic absorption bands has its maximum near the predicted wavelength. Results from the study of rutile show that a large radiation exposure, 10^{15} (nvt) fast, is required to produce a detectable change in its electrical resistivity. This change was found to be in the direction of increasing resistivity which suggests that the irradiation has introduced deep-lying electron levels that capture some of the conduction electrons. C.L.W.

N63-17617 California U., Livermore. Lawrence Radiation Lab.

APPLICATION OF THE DEBYE MODEL TO SCATTERING OF NEUTRONS FROM CRYSTALS

R. N. Stuart Mar. 5, 1963 34 p 11 refs
(Contract W-7405-eng-48)
(UCRL-7267) OTS: $0.75

A procedure is outlined whereby the differential scattering cross section for neutrons may be reasonably well calculated for solid moderating systems of a general nature. The Debye model is used as the basis for the calculations and it is applied to the case of a simple Bravais lattice. N.E.A.

N63-17623 Stanford U. Microwave Lab., Calif.

SECOND HARMONIC GENERATION USING FERRIMAGNETIC MATERIALS WITH MICROWAVE RESONATORS

Scientific Report No. 2

E. K. Kirchner Apr. 1963 179 p 32 refs
(Contract AF 19(628)-342)
(ML-1028; AFCRL-63-124)

Frequency doubling using ferrimagnetic materials with microwave resonators was investigated so as to be able to correlate theoretical and experimental results. A traveling-wave-type frequency doubler using polycrystalline strips of yttrium iron garnet and Ferramic R-1 was constructed. Although the efficiency of this device was low, it verified the basic theory developed by Auld, et al. Next, two ferrite frequency doublers employing microwave cavities were designed. One had a coaxial-type cavity and the other a rectangular cavity. The conversion efficiencies of these devices were still low, but the ferrite-cavity system was found to exhibit a coupled mode effect. Two points of maximum absorbed power and two points of maximum second harmonic power could be obtained as a function of frequency if the ferrite-cavity system was undercoupled to the input waveguide, the driving frequency adjusted to the cavity resonant frequency, and the d.c. magnetic field adjusted to the sample resonance. This coupled mode effect was included in a theoretical analysis which was found to be in excellent agreement with experimental results. A dielectric resonator–ferrite frequency doubling system was designed to further improve the conversion efficiency in order to investigate the high-power saturation effects. The C-factor (the second harmonic power divided by the square of the absorbed power) for this device when operating in the low-power square-law region was 1.4×10^{-2} watts^{-1}, which is one hundred time larger than any reported in the literature to date. An experimental method to determine the maximum frequency doubling conversion efficiency is also described. M.P.G.

N63-17702 General Electric Co. Flight Propulsion Lab. Dept., Cincinnati, Ohio

COMPUTER PROGRAMS DESCRIBING COLLISION CASCADES IN BINARY MATERIALS. II. WURTZITE STRUCTURE

D. G. Besco and J. R. Beeler, Jr. Feb. 1963 50 p 10 refs
(Contract AT(40-1)-2847)
(GEMP-200) OTS: $1.25

An IBM-7090 computer program calculates the results of knock-on cascades initiated by the injection of a single atom into a binary solid. The program represents an extension to the real wurtzite structure of beryllium oxide, of an earlier calculation in which, for simplicity, the cascade was confined to a square planar lattice. Interactions between atoms are computed using a hard-sphere approximation to the Bohr screened coulomb potential. Output from the computer includes a complete cascade history, including range and displacement statistics, and a listing of the final pattern of point defects. The program is designed to assist in interpreting the results of ion-bombardment experiments on BeO. Author

N63-17768 Edgerton, Germeshausen and Grier, Inc., Boston, Mass.

ANALYSIS OF EXPERIMENTAL RADIATION EFFECTS DATA

Report No. 4, Final Report, 1 June 1961–31 May 1962

John L. Vidrine July 31, 1962 92 p 3 refs
(Contract DA-36-039-SC-87306)
(EGG-B-2462)

The data obtained from the radiation effects monitoring system employed at Godiva II, Triga, and KEWB were reduced and analyzed. On the basis of plots of the experimental data obtained from the original magnetic tape records, an attempt was made to develop a suitable phenomenological expression for the effects of a pulsed nuclear environment on the I_{co} and H_{FE} characteristics of the selected semiconductor devices tested. Expressions were derived that appeared to satisfy the conditions upon the analysis of the experimental I_{co} and H_{FE} data. When subjected to mathematical reduction the expressions proved to be plausible from the standpoint of the physics involved. The results were entirely satisfactory on the basis of a phenomenological model. Author

N63-17769 Atomic Energy Commission. Div. of Technical Information, Washington, D.C.

REPORT OF THE PANEL ON HIGH ENERGY ACCELERATOR PHYSICS OF THE GENERAL ADVISORY COMMITTEE TO THE ATOMIC ENERGY COMMISSION AND THE PRESIDENT'S SCIENCE ADVISORY COMMITTEE

N. F. Ramsey (Harvard U.) et al Apr. 26, 1963 62 p
(TID-18636)

A review is presented of the status of high-energy accelerator physics, along with recommendations as to the future programs in this field. These recommendations include: (1) the construction by the Lawrence Radiation Laboratory of a high-energy proton accelerator of approximately 200 bev energy; (2) the development in the U.S. of the technological know-how of constructing and using storage rings with high-energy accelerators; (3) the support of intensive and extensive design and experimental studies at the Brookhaven National Laboratory; and (4) the construction near Madison, Wisconsin, of a 12.5-bev high-intensity fixed-field alternating, gradient accelerator by the Midwestern Universities Research Association. I.v.L.

N63-17811 University of Southern Calif., Los Angeles

THEORETICAL INVESTIGATIONS IN SOLID STATE PHYSICS USING DISPERSION RELATION TECHNIQUES

Peter Kraus and C. J. Pearson Wright-Patterson AFB, Ohio. Aeronautical Research Labs., May 1963 25 p 22 refs
(Contract AF 33(616)-7781)
(ARL 63-76)

Some properties of Jost functions are reviewed for real and complex angular momentum, and compared to the determinantal expansion. The exact phase shifts and Jost functions in the complex k-plane are calculated for S- and P-waves, and compared to the first- and second-order determinantal expansion. Author

N63-17893 Pennsylvania State U., University Park
FIELD ION MICROSCOPY OF IRON WHISKERS [Final Report]
Edwin W. Müller and Osamu Nishikawa Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, May 1963 31 p 5 refs
(Contract AF 33(616)-6397)
(ASD-TDR-63-138)

The field ion-microscope images of iron whiskers from various origins were observed, and differentiations between iron whiskers and specimens made of pure iron wire were studied. Indications of crystal defects such as screw dislocations and axial-disordered core structures were found. The influence of various gases on the iron surface under the extremely high electric field, and the diffusion of potassium ions into the iron lattice were observed. The operation of the field ion microscope with neon gas gives certain advantages for the study of easily field evaporating metals such as iron. Author

N63-17913 General Electric Co., Schenectady, N.Y.
RESEARCH AND DEVELOPMENT TO INVESTIGATE THE MICROSTRUCTURE OF THE INTERNAL MAGNETIC FIELD IN FERRO-, FERRI-, AND ANTIFERROMAGNETIC SOLIDS [Final Report, Mar. 1, 1962–Jan. 31, 1963]
D. S. Rodbell, T. W. Moore, and I.S. Jacobs Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Apr. 1963 33 p 55 refs
(Contract AF 33(657)-8462)
(ASD-TDR-63-208)

A number of research projects dealing with fundamental interactions and the microstructure of internal fields in selected magnetic materials are as follows. (a) The magnetocrystalline anisotropy and electron-spin resonance in single crystals of gadolinium metal are being investigated by microwave techniques, and correlated to static-field mechanical torque results. (b) The thermal expansion anomalies near the Curie points of the ferromagnetic metals, gadolinium and nickel (whose anomalies are of opposite sign), have been analyzed in terms of recent theoretical work which considers the interatomic separation dependence of the magnetic exchange. (c) An investigation to look for coherency strains in the cobalt particles precipitated in a copper–cobalt alloy has been initiated, using the nuclear resonance frequency of the particles as a sensitive probe. (d) The same alloy system is under study by ferromagnetic resonance techniques with a view to understanding its magnetic annealing. (e) The nuclear magnetic resonance of both Mn and As in the compound MnAs has been observed, and several questions of fundamental importance to an understanding of its hyperfine fields are raised by the results. (f) An exploratory study of electron tunneling into several ferromagnetic alloy systems has revealed new behavior that may cast light on current studies of the band structure of these alloys. (g) A study of the thermal expansion of α-Fe_2O_3 has been used to resolve questions concerning its Néel point and to predict the pressure dependence thereof. (h) Research into the antiferromagnetic behavior of $FeCO_3$ has been continued with the identification of a metamagnetic transition between 100 and 200 kOe. Author

N63-17949 Sandia Corp., Albuquerque, N. Mex.
METHODS OF PREDICTING THE PERFORMANCE OF SEMICONDUCTOR ELECTRONIC CIRCUITS AND SYSTEMS IN A NUCLEAR ENVIRONMENT
S. C. Rogers [1963] 10 p 9 refs
(SCDC-3045)

The most economical way of determining alterations of system performance caused by radiation combines analysis with an experimental technique intended for laboratory use. The analytical method requires that the performance of the system be expressed mathematically in terms of component performance. These equations are then solved, using component parameters appropriate to discrete radiation levels. This approach also can be used to determine the probability of system failure as a function of radiation exposure. The experimental technique involves measuring system performance after substituting radiation degraded components into it. Although this latter technique only yields the radiation levels for zero and 100% probability of failure, it is a simple and powerful tool. Exposing a system to radiation in order to determine failure levels or failure probabilities is not practical because the large variations normally encountered in semiconductor device parameters may cause failure to occur over a large range of radiation exposure levels. Author

N63-17955 Cornell U., Ithaca, N.Y.
RECOMBINATION LUMINESCENCE IN ALKALI HALIDES
T. Timusk and W. Martienssen Repr. from Phys. Res., v. 128, no. 4, Nov. 15, 1962, p 1656–1663
(NASA Grant NsG-212)
(NASA CR-50399)

A new type of luminescence in nominally pure alkali halide crystals was studied. At room temperature, the excitation was most efficient in the wavelength region that has been associated with band-to-band transitions. It is suggested that the emission results from the capture of a hole by an F center. In agreement with this model, the emission (430 mμ in KCl) is the same as that which is observed when a crystal containing α centers is irradiated in the α band at low temperature. From the thresholds of the excitation spectra the following band gaps are derived: NaCl, 8.0 ev; KCl, 8.1 ev; KBr, 7.3 ev; and KI, 5.8 ev. A comparison with external photoelectric thresholds as obtained by other investigations yields the electron affinities: NaCl, 0.8 ev; KCl, 0.6 ev; KBr, 0.9 ev; and KI, 1.6 ev. Author

N63-18063 Cornell U. Lab. of Atomic and Solid-State Physics, Ithaca, N.Y.
ULTRAVIOLET ABSORPTION OF THE MIXED SYSTEM KCl-KBr
Herbert Mahr Repr. from Phys. Rev., v. 122, no. 5, June 1, 1961 p 1464–1468 16 refs
(NASA Grant NsG-212-61; Contract Nonr-401(15); and ARPA SD-68)
(NASA CR-403)

The ultraviolet absorption of thin evaporated layers and the edge absorption of single crystals of the mixed system KCl-KBr were measured at room temperature in the photon energy range from 6 to 11 ev. In the thin layers, both the Cl^- and the Br^- absorption bands are present in the mixtures, and their heights depend on the relative concentrations of the two ions. The energy values of the bands generally shift with composition, although in contrast to all the other bands, the high-energy KBr band shifts very little. The results obtained for the low-energy absorption bands can be described by a simple semiclassical electron-transfer model. The behavior of the high-energy KBr band is discussed. Author

N63-18075 Brown U. Div. of Applied Mathematics, Providence, R.I.
ON THE DETERMINATION OF FREE ENERGY IN LINEAR VISCOELASTIC SOLIDS
S. Breuer and E. T. Onat Mar. 1963 19 p 7 refs
(Contract Nonr-562(10))
(C11-87)

A linear viscoelastic solid is subjected to simple tension or compression. An integral stress-strain law is employed in which the relaxation modulus is assumed to be the sum of exponential functions. This paper is concerned with the possibility of determining the free energy and rate of entropy production of the solid from the knowledge of the relaxation modulus. A thermodynamic approach is used. The free energy and rate of entropy production of the solid are assumed to be second-order functionals of the strain-rate history to which the solid has been subjected. An appeal to the first and second laws of thermodynamics is then found to place restrictions on the functionals. The further requirement, that the free energy of a solid in a completely relaxed state be zero, makes it possible to reduce the kernel appearing in the functional, defining the free energy to a bilinear sum of the exponentials which characterize the relaxation modulus. Author

N63-18148 American Optical Co., Southbridge, Mass.
NEODYMIUM GLASS LASER
Elias Snitzer 1962 23 p 8 refs Presented at the Third Intern. Symp. on Quantum Electronics, Paris, Feb. 1963
(Contract DA-19-020-ORD-5575)
(AROD-3209-2)

The properties of the neodymium glass laser in high power and in fiber configurations are discussed. The results are presented of recent experiments on spectral pumping efficiency, output as a function of time, influence of the glass base containing the neodymium, and spectral output. Author

N63-18178 Cornell U. Materials Science Center, Ithaca, N.Y.
ABSORPTION BAND SHAPE AND URBACH'S RULE IN IONIC CRYSTALS
Herbert Mahr Apr. 3, 1963 20 p 8 refs Submitted for Publication
(NASA Grant NsG-212-61; Contract Nonr-401(47); ARPA-SD-68)
(NASA CR-50405; Rept. 109) OTS: $1.60 ph, $0.80 mf

An empirical description of the shape of certain optical absorption bands in ionic crystals is proposed. The new formula links a nearly Gaussian description of the band near its maximum with an exponential description of the band on the low-energy tail (Urbach's rule). For the I⁻-absorption band in KCl, and the exciton bands in pure alkali halides, the applicability of the proposed shape formula over a wide range of absorption constants is demonstrated. A review of the theoretical background which led to the proposed description is given. Author

26 PROPELLANTS AND COMBUSTION

Includes: fuels; igniters; and oxidizers.

For related information see: 07 Chemistry; and 27 Propulsion.

N63-17511 Thiokol Chemical Corp. Elkton Div., Md.
EXPERIMENTS FOR THE MEASUREMENT OF THE ACOUSTIC IMPEDANCE OF A BURNING SOLID PROPELLANT Final Report [May 16, 1961-May 15, 1963]
Gordon Leader and C. C. Alfieri June 28, 1963 73 p 3 refs
(Contract Nonr-3473(00); ARPA Order 23-61 and ARPA Order 23-62)
(E104-63)

The feasibility of application of the method of O. K. Mawardi to the experimental measurement of the acoustic impedance of a burning propellant surface has been studied. Modifications needed for adaptation of this method to studies on a burning propellant have been made. Instrumentation needed for recording of sound level and microphone signal phase-angle shift relative to driver current during the short burning time of propellant samples, and for precise filtering of microphone output to minimize the effect of combustion noise was provided and tested. The Mawardi method was shown to be operationally feasible in the frequency range 200 to 2000 cycles per second. A modified calculation method, required to allow for the effect of vents on the acoustic performance of the sound chamber, was developed and shown to give fair agreement with established values when applied to measurements made on sound absorbing surfaces in the vented chamber. Active tests with adequate means for recording of microphone-signal intensity and phase angle were made at 200 psi with injected sound frequencies of 200, 500, 1000, and 1500 cps. At 200 and 500 cycles, these gave erratic results which are attributable to the sensitivity of the chamber sound-pressure level to vent area of the cavity and the effect of combustion conditions on this quantity. At 1000 and 1500 cycles, more stable and reproducible results were obtained, which can be correlated with the demonstrated insensitivity of chamber response to vent area in this range of frequencies. Author

N63-17534 Aerojet-General Corp. Solid Rocket Plant, Sacramento, Calif.
STATUS, IGNITION RESEARCH
R. L. Lovine, L. Y. Fong, and B. E. Paul Apr. 29, 1963 59 p 5 refs
(Tech. Memo. 218 SRP)

To relate igniter energy output to motor ignition, a model of solid propellant ignition is given. Difficulties inherent in the nonlinear partial differential equations of heat and mass diffusion describing the ignition system prevent the model from being completely analytical. However, certain results are derived from the equations, and when combined with arc image furnace ignition test data, a resonably coherent view of the process is obtained. The analysis of the internal ballistics of controlled mass flow igniters is presented, including the effects of a high weight fraction nongaseous material in the combustion products. Based on the assumptions of negligible thermal and velocity lags between the two phases of the flow, and constant mass fractions in any unit volume, the ballistic analysis becomes similar to that of single phase flow. Author

N63-17542 Aerojet-General Corp. Solid Rocket Plant, Azusa, Calif.
INVESTIGATION OF THE MECHANISMS OF DECOMPOSITION, COMBUSTION, AND DETONATION OF SOLIDS [Technical Operating Report No. 14, Apr. 1-June 30, 1963]
J. P. Kispersky June 1963 24 p 8 refs
(Contract AF 49(638)-851; ARPA Order 24-60)
(Rept. 0372-01-14)

"Apparent flame strengths" for the ammonia-oxygen and ammonia-oxygen-chlorine reactions have been determined as a function of reactor pressure, using the opposed-jet technique and 0.77-cm-ID nozzles. It has been shown that the ammonia-oxygen flame strength is dependent on the square of the reactor pressure when both 0.46- and 0.77-cm jets are used. The proportionality of the flame strength with the diameter of the jet, which is required by theory, has also been demonstrated.

"Apparent flame strength" measurements for ammonia as fuel, with oxygen-chlorine mixture as oxidizer, have been made at 300, 450, 600, and 745 torr. The flame strength was inversely proportional to the mass fraction of Cl_2 in the mixture. Extrapolations to zero flame strength indicated that no flame is possible at mass fractions of chlorine of approximately 0.5. Analyses of the data for ammonia-oxygen-chlorine systems indicate that chlorine does not act as a diluent but competes with oxygen in reaction with NH_3. The three-component system also shows flame strength dependence on the square of the reactor pressure. Author

N63-17598 Bureau of Mines. Petroleum Research Center, Bartlesville, Okla.

MINERAL INDUSTRY SURVEYS: AVIATION FUELS, 1962

O. C. Blade June 1963 23 p 3 refs
(Petroleum Products Survey 29)

Analytical data are presented for 95 samples of aviation gasoline and for 97 samples of aviation turbine fuel. The data are inspections reported by the manufacturers as typical of their 1962 production. The analyses were made in their laboratories and the results submitted to the Bureau of Mines for compilation. The products of 14 manufacturers of aviation gasolines and of 15 producers of aviation turbine fuels are represented. The term "aviation turbine fuel" replaces "jet fuel" used in these reports before 1960. Author

N63-18037 Aerojet-General Corp., Azusa, Calif.

DESIGN GUIDE FOR PRESSURIZATION SYSTEM EVALUATION LIQUID PROPULSION ROCKET ENGINES. VOLUME I- USE OF DESIGN GUIDE, GENERAL DESIGN DATA Report Covering Period, 19 Apr. 1961 through 30 Sept. 1962

F. W. Childs, T. R. Horowitz, W. Jenisch, Jr., and B. Sugerman
Sept. 30, 1962 137 p
(NASA Contract NAS7-169)
(NASA CR-50313; Rept. 2334) OTS: $10.51 ph, $4.31 mf

This design guide is presented to provide a systematic and rapid procedure for the selection of the most suitable liquid rocket pressurization system on the basis of specific missions requirements. Both a method and the necessary data for the selection of the most suitable liquid rocket pressurization system are presented. Each of the four design parameters or rating factors which are now covered by the design guide is given a numerical function which is based on the mission requirements. These rating factors are reliability, weight, volume, and cost. The numerical functions are called influence coefficients, and each system is evaluated by the product of its four influence coefficients. Thus, each system considered receives a numerical rating. The system receiving the highest numerical rating is the best suited for the mission. The method is objective in that the influence coefficient curves are chosen directly from the mission objectives and prior to the consideration of the system. I.v.L.

N63-18061 Directorate of Engineering Test, Aeronautical Systems Div., Wright-Patterson AFB, Ohio

SUPERSONIC HYDROGEN COMBUSTION STUDIES [Final Report, Mar. 1962-Apr. 1962]

Duane R. Burnett and Paul Czysz Apr. 1963 41 p 3 refs
(ASD-TDR-63-196)

The purpose of this test was to develop diagnostic techniques for the detection of hydrogen combustion in a hypersonic high-temperature airstream. This was accomplished by ejecting hydrogen through sonic nozzles oriented normal to the airstream in the case of the flat-plate model, and at a 45-degree angle downstream in the case of the stepped flat-plate model. The hydrogen gas was ejected into a high-temperature airstream ($T_0 \approx 4000°$ R) at Mach number 4.14 to 4.24. The data are presented in three forms: (1) photographs, (2) graphs, and (3) oscillograph traces. Author

27 PROPULSION

Includes: airbreathing, electric, liquid, nuclear, and solid propulsion.

For related information see: 04 Aircraft; 06 Auxiliary Systems; 26 Propellants and Combustion; and 30 Space Vehicles.

N63-17517 General Electric Co. Space Power and Propulsion Section, Cincinnati, Ohio

INVESTIGATION OF ELECTRICAL SYSTEMS OF PLASMA ARC JET ENGINES

Robert Richter New York, AIAA [1963] 46 p Presented at AIAA Electric Propulsion Conf., Colorado Springs, Colo., Mar. 11-13, 1963
(NASA Contract NAS8-2415)
(AIAA Paper 63044) AIAA: $0.50 members, $1.00 nonmembers

A discussion of the operation of plasma arc-jet engines is presented. The stability with respect to operating point is briefly reviewed, and the analytically determined minimum-electrical-component values for stabilizing d.c., single phase a.c., and three-phase a.c. are presented. The results are applied and experimentally obtained arc characteristics. The two instabilities which are characteristic of the a.c. arc only, that is, instability with respect to arc operation and instability with respect to system oscillation, are presented by citing experimentally found interdependences between arc operation and electrical-component values. Experimental techniques for starting a three-phase plasma arc-jet engine are presented. Author

N63-17549 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

MECHANICAL IMPEDANCE STUDY OF THE X-259 ROCKET MOTOR

Raymond G. Hartenstein and William G. Elsen Washington, NASA, June 1963 24 p 1 ref
(NASA TN D-1681) OTS: $0.75

The impedance analysis of the X-259 rocket motor and roll-rig firing assembly indicates that the roll rig gives a soft spring effect to the rocket motor which, if unaccounted for, could lead to the misinterpretation of vibration levels especially in the higher frequency range. The mechanical impedance concept has proved to be a straightforward and plausible method of analyzing this phenomenon and, at the same time, increases the general usefulness of static firing data. To define the static firing arrangement completely, a study of the thrust cell mounted against the firing bay wall was also made. This study revealed the dynamic character of the thrust cell and provided excellent correlation with the design parameters of the device. Author

N63-17807 Avco Corp. Research and Advanced Development Div., Wilmington, Mass.

THIRTY DAY ENDURANCE TEST OF A 30KW ARC JET ENGINE

R. R. John, J. F. Connors, and Stewart Bennett N.Y., AIAA [1963] 38 p 3 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963
(NASA Contract NAS5-600)
(AIAA Paper 63-274) AIAA: $0.50 members, $1.00 nonmembers

Details are presented on a 30-day run of a radiation-cooled thermal arc-jet engine. The engine performed satisfactorily throughout the test period, maintaining a thrust of 250 grams, and a propellant specific impulse greater than 1000 seconds at an input power level of 30 kilowatts. The resulting propulsive efficiency was greater than 40 percent. Visual examination of the arc discharge through a quartz constrictor indicates that there is a smooth, constant diameter, bright core extending from the cathode completely through the constrictor to the cathode. Photographic observations on the arc discharge, using a red filter, indicate that the center of the column is darker than the outside; and this, in turn, suggests that the maximum core temperature is greater than 20,000° K. Calculations on the energy flow rate through a fully developed laminar column, combined with the experimental observation that the longitudinal energy flux gradient along the column is small, suggest that there may be a region of high volumetric energy release in the vicinity of the cathode tip. Author

N63-17813 Aerojet-General Corp., Azusa, Calif.

ADVANCED SPACE MISSION CAPABILITIES OF NUCLEAR ROCKETS

Walter C. Beckwith and Helmer L. Johnson N.Y., AIAA [1963] 24 p Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963
(AIAA Paper 63-286) AIAA: $0.50 members, $1.00 nonmembers

A study has been conducted to provide performance, operational cost and reliability data for the SATURN V and NOVA launch vehicles using nuclear engines, and to estimate the possible mission capabilities. Results indicate the following: (1) The SATURN V chemical/nuclear system yields approximately a 60%-payload improvement over the all chemical SATURN V. This ratio is seen to decrease on the NOVA vehicle to about 50%. This reduction is primarily a reflection of the reduced thrust of the nuclear stage relative to the first stage vehicle. (2) Nuclear propulsion has a unique position operationally and economically, particularly in the velocity range of V_{∞} = 0 to 40,000 ft/sec, and (3) Lunar manned and logistics flights, Mars/Venus flights, and deep space probes with increased payload capabilities will be possible. I.v.L.

N63-17921 California U., Berkeley

RECENT PROGRESS IN DETONATION RESEARCH AND ITS RELATION TO ROCKET PROPULSION

N. Manson (Poitiers U., France), H. G. Wagner (Göttingen U.), and A. K. Oppenheim N.Y., AIAA, [1963] 20 p 107 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963
(NASA Grant NsG-10-59 and AF AFOSR Grant 129-63)
(AIAA Paper 63-227) AIAA: $0.50 members, $1.00 nonmembers

Recent studies of the gaseous phase of detonation phenomena concerned with the development, stability, and structure of the detonation wave are discussed. The importance of detonation research to rocket technology is that a detonation wave produces conditions resembling those prevalent in high performance thrust chambers, thereby serving as a means of studying rocket chemico-kinetic and gas-wave-dynamic processes. Wave development studies covered: the generation of pressure waves by accelerating flames, and the observation of the onset of transverse oscillations when the detonation wave originates. Stability studies include: the observation of small amplitude, high-frequency oscillations of the wave, the observation of low-frequency instability, associated with actual separation of the combustion zone and the shock front, and the observation of a nonsteady wave, which is often a multidimensional configuration. Wave structure studies covered: the kinetics of chemical reactions under nonequilibrium conditions of pressure and temperature gradients, the von Neumann-Doring-Zeldovich theory of two wave fronts in a detonation—one shock and one deflagration, and the turbulent character of the detonation wave. D.E.R.

N63-17941 Bell Aerosystems Co., Buffalo, N.Y.

SMALL ROCKET LIFT DEVICE. PHASE III – TESTING OF THE ASSEMBLED SYSTEM Technical Report [Dec. 22, 1961-Dec. 15, 1962]

Wendell F. Moore Fort Eustis, Va., Army Transportation Research Command, Apr. 1963 185 p 5 refs
(Contract DA-44-177-TC-642)
(TRECOM Tech. Rept. 63-12)

Results of additional rocket belt stability and control studies are presented. The successful design, fabrication, and test of a propellant quantity sensing and warning system is described. Rocket belt pilot preliminary selection and training criteria were established, as well as a preliminary training program. The results of experiments with an inflatable paraglider are presented. Data on advanced design configurations are summarized. Author

N63-17986 National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio

ANALYSIS OF THE LIQUID-METAL TURBOJET CYCLE FOR PROPULSION OF NUCLEAR POWERED AIRCRAFT

William W. Wachtl and Frank E. Rom Washington, NACA, Nov. 19, 1951 87 p 8 refs
(NACA RM E51D30) OTS: $8.10 ph, $2.81 mf (Declassified)

An analysis of the nuclear-powered liquid-metal turbojet cycle is presented for a wide range of engine operating conditions at flight Mach numbers of 0.9 and 1.5, and at altitudes of 30,000 and 50,000 feet. The method of analysis and working charts are presented to facilitate investigations beyond the scope of this report. The thrust per engine plus heat-exchanger weight is optimized at the four flight conditions for heat-exchanger inlet Mach number, compressor pressure ratio, and turbine-inlet temperature for a range of liquid-metal-to-air heat exchanger effective wall temperatures. Airplane gross weight and reactor heat release is presented for typical values of airplane lift-drag ratio, structure to gross weight ratio, and sum of reactor, shield, payload, and auxiliary weights. The effect of varying these assumptions and of including nacelle drag is shown along with the effect of flight conditions. Author

N63-18003 California U., Livermore. Lawrence Radiation Lab.

CONTROL OF THE BLOWDOWN AIR SUPPLY FOR THE TORY II-C NUCLEAR RAMJET ENGINE

R. B. Hollstien Feb. 1, 1963 100 p 5 refs
(Contract W-7405-eng-48)
(UCRL-7145) OTS: $2.25

The blowdown control for the Tory II-C operations is designed, using an approximation of the process inverse in an open-loop computer, which is combined with corrective feedback loops to control the weight flow and temperature of air delivered to the reactor. A method of extending the control capability to include the simulation of reactor inlet conditions during the launch of nuclear-powered missiles is described. The analysis, design, and description of the expected performance are based on an analog computer model of the blowdown system. Author

N63-18161 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

THE SIGNIFICANCE OF ATMOSPHERIC BALLISTICS IN ROCKET TECHNOLOGY

G. H. R. Reisig Washington, NASA, July 1963 101 p 34 refs
(NASA TN D-1830) OTS: $2.50

The physical properties of the atmosphere pertain to the basic elements of rocket ballistics. The influence of these atmospheric properties on both rocket design and performance is grouped under three topics, namely: (a) rocket design climatology, (b) atmospheric rocket physics, and (c) atmospheric environments for rocket firings. Author

N63-18184 Aerojet-General Corp. Liquid Rocket Plant, Sacramento, Calif.

ABLATIVE THRUST CHAMBER FEASIBILITY Product Engineering Final Report

T. A. Hughes June 28, 1963 100 p refs
(Contract AF 04(647)-652)
(Rept. 652/SA4-2.2-F-1, Vol. 1; BSD-TDR-63-118)

The design, fabrication, and assembly of six large-scale ablative thrust chambers, utilizing the compression-molded, building-block concept is described. The chambers were designed for evaluation and demonstration of the feasibility for in-space use, at chamber pressures of 40 to 300 psia, and thrust equivalents of 5,100 to 38,000 lb for durations up to 20 min. Materials were evaluated in 36 subscale engine tests. Author

N63-18205 Aerojet-General Corp. Solid Rocket Plant, Sacramento, Calif.

ALGOL SOLID ROCKET MOTOR PROGRAM Twentieth Monthly Progress Report, Jan. 1963

Feb. 1963 20 p
(NASA Contract NAS1-1330)
(NASA CR-50629; Rept. 0498-01M-20) OTS: $1.60 ph, $0.80 mf

The fabrication, testing, and delivery of Algol solid rocket motors for the Scout vehicle is reported. Motors SN 15, 16, 17, and 18 were cast. The IIA-3 rehabilitated chamber is being cast for firing. Motor IIA-13 is ready to be radiographically inspected and delivered as soon as the nozzle is installed. Motors IIA-14 and IIA-15 are also ready for radiographic inspection; and Motors IIA-16 and IIA-17 are in process. Laboratory and subscale motor firing data are being collected for a burning rate study; these data will be compared with flight test data when available. An igniter squib-test program is also being conducted, and the tests to which the squibs will be subjected have been established. M.P.G.

N63-18206 Aerojet-General Corp. Solid Rocket Plant, Sacramento, Calif.

ALGOL SOLID ROCKET MOTOR PROGRAM Twenty-First Monthly Progress Report, Feb. 1963

Mar. 1963 19 p
(NASA Contract NAS1-1330)
(NASA CR-50628; Rept. 0498-01M-21) OTS: $1.60 ph, $0.80 mf

The fabrication, testing, and delivery of Algol solid rocket motors for the Scout vehicle are reported. Motors Algol IIA-3 (rehabilitated) and IIA-19 were cast. The scheduled firing of the Algol IIA-3 was delayed to incorporate the use of an igniter with an improved initiator seal. The status of Motors IIA-14 through IIA-18 is reported. Telemetry data received on flight-tested Algol Motors IIA-4, IIA-5, and IIA-6 indicate excellent agreement between measured and predicted burning rates. The burning rate study will be continued, and, as the number of motors processed, fired and/or launched increases, the data acquired will be useful for predicting Scout vehicle performance. M.P.G.

N63-18207 Aerojet-General Corp. Solid Rocket Plant, Sacramento, Calif.

ALGOL SOLID ROCKET MOTOR PROGRAM Twenty-second Monthly Progress Report, Mar. 1963

Apr. 15, 1963 67 p
(NASA Contract NAS1-1330)
(NASA CR-50652; Rept. 0498-01M-22) OTS: $6.60 ph, $2.21 mf

The fifth full-scale static firing using the Algol IIA-3 (Rehab) rocket motor was conducted. All aspects of the firing were normal except for a 3.7-sec hangfire. The total delivered impulse was 4,740,000 lbf/sec over an action time of 66.5 sec; delivered specific impulse was 223.6 lbf-sec/lbm. The web burning time was 45.1 sec and the web impulse was 4,107,180 lbf/sec. Since the hangfire was attributed to the smooth grain surface that resulted from the use of the aluminum hard core, an igniter-recovery program was initiated so as to improve motor ignitions characteristics. I.v.L.

N63-18208 Aerojet-General Corp. Solid Rocket Plant, Sacramento, Calif.

ALGOL SOLID ROCKET MOTOR PROGRAM Twenty-third Monthly Progress Report, Apr. 1963

May 15, 1963 40 p
(NASA Contract NAS1-1330)
(NASA CR-50635; Rept. 0498-01M-23) OTS: $3.60 ph, $1.40 mf

The sixth full-scale static firing using the Algol IIA-18 rocket motor was conducted and all test objectives were achieved. This is the first test in which jet vanes were not used; therefore, it was not necessary to correct ballistic data obtained for the axial impulse loss due to the jet vanes. The total delivered impulse of this rocket motor was 4,726,314 lbf/sec; action time was 67.9 sec; specific impulse was 223.2 lbf-sec/lbm. The web burning time was 48.1 sec, and the web impulse was 4,173,352 lbf/sec. As a result of the hangfire that occurred in the test of Algol IIA-3 (Rehab), an igniter-recovery program was conducted. This program consisted of the testing of both existing igniters (1400-gm main charge) and four modified igniters in a simulated free-volume chamber. A modified igniter was also used in the Algol IIA-18 during the sixth static firing. A study was made to determine if the wax coating left on the surface of the grain after removal of the core had any effect on ignition. In conjunction with this study, propellant samples were taken from the grain surfaces of motors Algol IIA-13 and Algol IIA-19 and were photographed and chemically analyzed to determine wax-residue and ammonium perchlorate (oxidizer) content. The delivery of all motors and the processing of motors subsequent to Motor Algol IIA-20 were suspended pending results of the igniter-recovery program. I.v.L.

28 SPACE RADIATION

Includes: cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts.

***For related information see:* 05 Astronomy and Astrophysics; 16 Life Sciences; and 29 Space Sciences.**

N63-17655 Martin-Marietta Corp. Aerospace Div., Denver, Colo.
SOLAR COSMIC RAY EVENTS AND THEIR INTERPRETATION. PART I: INTRODUCTION
David Reitz May 1963 33 p 75 refs
(R-63-8 (Pt. I))

This research report is devoted to the optical classification of flares; the relations between energy, momentum, and rigidity; general spectral representations; charged-particle penetration of the geomagnetic field; possible solar generation mechanisms for cosmic rays; and solar-particle detectors. Author

N63-17703 International Geophysical Year World Data Center A: Solar Activity, High Altitude Observatory, Boulder, Colo.
CORRECTIONS TO THE NATIONAL BUREAU OF STANDARDS LIST OF INTERNATIONAL GEOPHYSICAL YEAR FLARES
Constance S. Warwick May 15, 1963 16 p 1 ref
(IGY Solar Activity Rept. Ser.-17, Addenda)

A list of suggested changes in the NBS list of IGY flares (IGY solar activity report series, number 17, 1962) is presented. Most of the changes have to do with the grouping of reports pertaining to a single flare. Eighty-eight cases in the grouping of the NBS list are believed to be incorrect with errors occurring among the larger flares. The changes to be made are presented in two lists: (1) entries to be deleted from the original list and (2) entries to be added to the original list. The corrected list of flares that have importance of 2- or greater are presented. The net change in the number of flares of each importance, and the total number after correction are given. Changes, other than in the grouping, are in beginning or maximum time, or in order of entries. N.E.A.

N63-17739 Iowa State U., Iowa City
COMMENTS ON A PAPER BY W. N. HESS ENTITLED "THE ARTIFICIAL RADIATION BELT MADE ON JULY 9, 1962"
B. J. O'Brien Feb. 1963 25 p 15 refs For Hess paper, see N63-14714 10-28
(SUI-63-5)

Based on data from the Telstar satellite, the Injun space probe, and the Ariel satellite, the sketch of the artificial radiation belt produced by the Starfish high-altitude nuclear explosion of July 9, 1962, as drawn by Hess in his paper on that belt, is criticized. This is the figure of the contours of intensity of the electrons produced by the bomb. The figure is generally agreed to be accurate at low altitudes ($L \leq 1.2$ earth radii), based on a number of satellite observations of the radiation belt electrons after the explosion, but the contours of the figure are not agreed upon for higher altitudes ($L \geq 1.3$) when they are drawn, as were Hess's, from Telstar data. The Telstar satellite was not launched until after the detonation, and its detectors respond to high-energy electrons of several hundred kilovolts, allowing contamination by natural Van Allen electrons. Then, too, there is disagreement on the height of the peak intensity of the fission electrons, and the shape of the belt at half-peak intensity. Hess's use of the measurements of the Ariel satellite is attacked as incomplete, and his sketch of (B,L) space as studied by the Injun I satellite is criticized as incomplete. D.E.R.

N63-18145 Space Technology Labs., Inc., Redondo Beach, Calif.
A COMPREHENSIVE MAP OF THE SPACE RADIATION ENVIRONMENT Final Report
A. Rosen, C. A. Eberhard, T. A. Farley, and J. L. Vogl Sept. 28, 1962 274 p 95 refs
(Contract AF 41(609)-1456)
(Rept. 8644-6002-RU-000)

It is certain that much of the data forming the basis for the radiation environment today will be made obsolescent by more definitive data gathered in the future. The present edition is considered a skeleton document which contains the format, ground rules, and a large fraction of the data that are to be incorporated in future editions of the handbook. The data presented for the inner radiation zone should be regarded as characteristic of that region prior to the July 9 detonation. Author

N63-18167 Iowa State U., Iowa City
LATITUDE SURVEY OF COSMIC RAY INTENSITY BY EXPLORER VII, OCTOBER 1959 TO FEBRUARY 1961
W. C. Lin, D. Venkatesan, and J. A. Van Allen Apr. 1963 39 p 39 refs
(NASA Grant NsG-233-62; Contract N9onr-93803)
(NASA CR-50419; SUI-63-13) OTS: $3.60 ph, $1.37 mf

Using a shielded Geiger tube in the Explorer VII satellite, a comprehensive geographic survey has been conducted of the intensity of charged particles in the latitude range ±50.5°, in the altitude range 550 to 1100 km, and over the sixteen-month time period from October 13, 1959, to February 17, 1961. It has been found possible to identify and eliminate contributions by geomagnetically trapped particles, and thus to obtain the absolute intensity of primary galactic cosmic rays and their charged-particle secondaries (albedo) produced in the atmosphere. Specific results are given. Author

29 SPACE SCIENCES

Includes: space chemistry; cosmology; lunar and planetary exploration; and theoretical analysis of orbits and trajectories.

For space biology see: 16 Life Sciences.

For related information see: 05 Astronomy and Astrophysics; 12 Geophysics; and 22 Navigation and Guidance.

N63-17588 Liège U. Inst. d'Astrophysique (Belgium)
COLLISIONS BETWEEN WEST FORD NEEDLES AND MICROMETEORITES Technical Note No. 2
A. Sauval May 10, 1963 11 p 37 refs
(Contract AF 61(052)-587)
(AFCRL-63-649)

Over a period of eight years, there are enough collisions of micrometeorites with the needles of Project West Ford to break most of them. Author

N63-17656 National Aeronautics and Space Administration, Washington, D.C.
NASA LOOKS AHEAD—A REVIEW OF AMERICA'S PLANS FOR EXTENDING SPACE RESEARCH AND TECHNOLOGY OVER THE NEXT TEN YEARS
Morton J. Stoller Repr. of the abridged text of a lecture given before the British Interplanetary Soc., London, Oct. 1, 1960 p 70–77

The objectives for extending NASA space research and technology over the next ten years are discussed. These are: (1) to investigate the energy transfer relations between the sun and earth, and to study other solar–terrestrial relations; (2) to probe the origin and fundamental workings of the solar system and the universe; and (3) to search for the origin and distribution of life within our solar system. That portion of the space program which will be accomplished by sounding rockets, near-earth probes, and artificial satellites is then discussed in detail.

The Explorer satellite system is described, as are the solar satellite, the Ranger and Mariner projects, a mobile, lunar surface probe, satellite meteorology, plans for man-in-space, and communications systems in space. D.E.R.

N63-17697 Konkoly Observatory, Budapest (Hungary)

DISCOVERY OF OVERTONES AND RESONANCE OSCILLATIONS IN BETA CANIS MAJORIS AND IN BETA CEPHEI

A. Van Hoof (Louvain U., Belgium) Jan. 14, 1962 2 p
(Comm. 27 of the I.A.U. Inform. Bull. on Variable Stars No. 4)

An investigation on the radial velocity variation of Beta Canis Majoris (BCM) and of Beta Cephei (BC) has disclosed the existence of different oscillations. In BCM, the oscillations (ten) found include the free pulsations in the fundamental mode and in the first five overtones and the difference oscillations. In BC, the oscillations (55) found include the first ten overtones, the difference oscillations, and the further difference oscillations. R.C.M.

N63-17733 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

ANALYSIS OF THE ENERGY DEPENDENCE OF THE ISOMER RATIO IN THE $Sn^{120}(p\alpha)In^{117,117m}$ REACTION

John L. Need Repr. from Phys. Rev., v. 129, no. 3, Feb. 1, 1963 p 1302–1307 19 refs

The method of Huizenga and Vandenbosch for calculating isomer ratios has been extended to reactions that constitute a small fraction of the total cross section. In particular, the method determines the effective distribution in J for emission of particles *a* brought about by competition between the emission of neutrons and particles *a*. The method is then applied to the reaction $Sn^{120}(p,\alpha)In^{117,117m}$, and values of σ, the parameter that characterizes the spin distribution, are extracted by comparison with experiment. The values of σ obtained for proton bombarding energies of 12 and 18 Mev are 2.7 and 4.2, respectively, and do not depend strongly upon the value of σ chosen for the neutron evaporation, but do depend strongly upon the fractional amount of direct interaction assumed. Similar values for σ are obtained when competition is not considered. The energy dependence of σ is discussed in the light of present theory. Author

N63-17753 Lockheed Missiles and Space Co., Sunnyvale, Calif.

HIGH-VACUUM EFFECTS ON ELECTRONIC PARTS, MATERIALS, AND RELATED PROBLEMS: AN ANNOTATED BIBLIOGRAPHY [Covering Period Jan. 1960-Mar. 1962]

Eugene E. Graziano, comp. Apr. 1962 67 p 124 refs
(Contract AF 04(647)-787)
(SB-62-15; Rept. 3-77-62-12)

The purpose of this literature search was to secure technical information regarding experience with electronic parts and materials in high-vacuum environments. Due to the relative sparseness of such information, the scope of the search was extended to include selected references on sublimation, vapor pressures, electronic phenomena in high vacuum, etc. An intensive search was made for the period January 1960–March 1962, and selected references were included to earlier materials if citations were made to these earlier articles in the current literature. Author

N63-17766 General Electric Co. Space Sciences Lab., King of Prussia, Pa.

NUMERICAL SOLUTIONS ON THE ASTRONAUTICAL PROBLEM OF THRUST VECTOR CONTROL FOR OPTIMUM SOLAR SAIL TRANSFER

C. R. Cavoti Mar. 1963 63 p 26 refs Presented at the ARS 17th Ann. Meeting and Space Flight Exposition, Los Angeles, Calif., Nov. 13–18, 1962
(R63SD30)

The problem of optimum orbital transfer by means of best control of a solar radiation pressure thrusting device is considered. The method of analysis is based on a general approach using the indirect variational techniques. The study presented is concerned with the problem of optimum solar sail orbital transfer, such that the vehicle departing from an initial circular orbit arrives with maximum orbit velocity (also called injection velocity) at a given distance from the sun. For those cases where the maximum orbit velocity, at the given distance from the sun, corresponds with elliptical orbit velocity, the variational problem considered is therefore equivalent to an orbital transfer with maximum "visviva" or to the ellipse of maximum semi-major axis. The boundary value problem associated with the natural and physical end-conditions is solved numerically, and a generalized graphical construction solving for the initial values of the multipliers, for given final radius (or distance from the sun), is presented. Author

N63-17803 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

A TECHNIQUE FOR OPTIMUM FINAL VALUE CONTROL OF POWERED FLIGHT TRAJECTORIES

Carl G. Pfeiffer N.Y., AIAA [1963] 12 p 8 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963
(NASA Contract NAS7-100)
(AIAA Paper 63-267) AIAA: $0.50 members, $1.00 non-members

A technique is developed for controlling the acceleration vector along a powered flight trajectory, the scheme being based upon considering linear perturbations about a standard (nominal) trajectory. It is assumed that the standard trajectory has been optimized by choosing a control program which, for the given initial condition, causes the final state to be attained in such a way as to minimize an explicit function of the end coordinates and time, subject to certain end constraints. The task, then, is to construct a perturbed control program, to be applied between the initial and final time, which will reoptimize the trajectory in the presence of small disturbances to the initial conditions. Author

N63-17806 California Inst. of Tech. Seismological Lab., Pasadena

SEISMIC EXPLORATION OF THE MOON

R. L. Kovach, Frank Press, and Francis Lehner N.Y., AIAA 1963 8 p 8 refs Presented at AIAA Summer Meeting, Los Angeles, June 17–20, 1963
(NASA Contracts NASw-81 and NAS7-100)
(AIAA Paper 63-255) AIAA: $0.50 members, $1.00 non-members

The single axis seismometer, carried aboard the Ranger flights 3, 4, and 5, is described as containing a coil, a spring-suspended magnet, and an internal calibration device with a permanent magnet suspended from the body of the instrument acting as the seismic mass. Movement of the coil produces the transducer output. The seismic data are transmitted to earth via telemetry signals. For other lunar missions, a new, lightweight, compact, three-component seismometer is being developed. Equipped with displacement transducers and long-term recording equipment, the instrument will transmit data on moonquakes and seismic signals from meteoric impact over long periods. Lunar seismograms are explained in theory and their value in analyzing the lunar surface and structure is explained. D.E.R.

N63-17809 National Aeronautics and Space Administration, Washington, D.C.
ADDRESS BY JAMES E. WEBB, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, UNIVERSITY OF DELAWARE COMMENCEMENT, NEWARK, DELAWARE, JUNE 9, 1963 News Release
James E. Webb June 9, 1963 14 p
Available from NASA. Office of Scientific and Technical Information, Wash., D.C.

Two of the more intangible motivations which have prompted a bold and aggressive effort to conquer space are discussed; these are (1) the need to maintain U.S. international position of leadership and (2) the compelling urge of man to learn and discover. The first motive encompasses far more than the propaganda factor and extends to the realization that the only two countries in a financial position to conquer space represent, in the eyes of men everywhere, two competing systems of economic organization—capitalism vs. communism. The conquest of space has become a symbol of the challenge to each system to demonstrate its superiority; further, it is undoubtedly better to compete by shooting dollars into space than by shooting them at each other. The second less tangible motive for space exploration, the urge to explore the unknown, has been the wellspring of civilization throughout the centuries, the deep driving force that has caused man to rise to unparallelled accomplishments. Another aspect is the vitality a nation obtains from being engaged in a great adventure, and the interstellar fun of putting a man on the Moon or Mars. The accomplishments of the brief ten-year span of space exploration are reviewed, and the opportunity for graduates of today to carry forward the banner of civilization is stressed. M.P.G.

N63-18035 Southwest Center for Advanced Studies, Dallas, Tex.
THE DISTRIBUTION OF INTERPLANETARY HYDROGEN
T. N. L. Patterson, F. S. Johnson, and W. B. Hanson Mar. 5, 1963 27 p 11 refs Submitted for Publication
(NASA Grant NsG-269-62)
(NASA CR-50331) OTS: $2.60 ph, $1.01 mf

A calculation is presented of the distribution of the neutral hydrogen in interplanetary space. The work described here is an extension of a recent theory of Axford, Dessler, and Gottlieb on the termination of the solar wind. These authors have proposed that a shock front is formed in the region where the momentum flux of solar protons just equals the pressure exerted by the galactic magnetic field. Beyond the shock front, the solar protons velocities become randomized but remain approximately equal to the solar wind velocity. These energetic protons in time undergo charge exchange with the neutral galactic hydrogen, creating an isotropic source of high-energy neutral hydrogen atoms, some of which move in the general direction of the sun. The distribution of neutral hydrogen around the sun, resulting from this flux of neutral hydrogen atoms, is calculated taking account of their loss by photoionization and charge exchange on their path toward the sun. The absolute concentration of hydrogen from this source is derived using the results of Morton and Purcell. Author

N63-18119 Aerospace Corp. Systems Research and Planning Div., Los Angeles, Calif.
TAKE-OFF FROM A CIRCULAR ORBIT BY LOW CIRCUMFERENTIAL THRUST
B. Billik Jan. 24, 1962 26 p 6 refs
(Contract AF 04(647)-930)
(DCAS-TDR-62-27; TDR-930(2560-40)TN-1)

The motion of a satellite, which is initially in a circular orbit about the earth, traveling under the action of a constant circumferential acceleration is analyzed. The radius and angular momentum of the vehicle are obtained as functions of the time. These expressions are believed to be very accurate over most of the trajectory traversed by the vehicle before escape conditions are met. Due to the complexity of these equations, a set of simplified expressions for the radius, angular momentum, radial velocity, speed, and flight-path angle are also obtained. The simplified equations are more amenable to computation, but are accurate over a more restricted range of radial distance. In general, these latter equations indicate a damping out of periodic terms as the vehicle recedes from the earth. The approach utilized in this report is believed to be unique insofar as its application to low-thrust problems is concerned. Specifically, the equations-of-motion are linearized by introducing a new variable, which is defined as the difference between the square of the instantaneous angular momentum of the actual orbit and that of a circular orbit at the instantaneous radius. The linearized equations are then solved for this quantity as a function of the time. Author

N63-18194 Ohio State U. Research Foundation, Columbus
STELLAR BACKGROUND MEASUREMENT PROGRAM Semi-annual Technical Report No. 1, Apr. 1, 1963–June 15, 1963
Philip E. Barnhart and Walter E. Mitchell, Jr. June 19, 1963 9 p 10 refs
(Contract DA-33-019-AMC-105(Z); ARPA Order 39, Amend. 38; Proj. Defender)
(Rept. 1636-1)

Progress is reported in a program designed to specify the actual character of the infrared stellar background. The photometer used is designed to measure the wave bands 2 to 2.4, 3.2 to 4.2, and 8 to 13 microns. Stellar irradiance data are obtained in the atmospheric windows between 1.6 and 13 microns. The detectors used and the method of packaging and mounting the strontium titanate field lens and a germanium immersed plumbide lens are discussed, and the computer program used to store the data received is given. D.E.R.

30 SPACE VEHICLES

Includes: launch vehicle—spacecraft combinations; operating problems; and stability and control.

For manned space capsules, satellites, and space probes see: 32 Space Vehicles (Spacecraft).

For boosters and rockets see: 31 Space Vehicles (Launch Vehicles).

For related information see: 04 Aircraft; 08 Communication; and 22 Navigation and Guidance.

N63-17639 Lockheed Missiles and Space Co., Sunnyvale, Calif.
MISSILE PHENOMENOLOGY: AN ANNOTATED BIBLIOGRAPHY
George R. Evans, comp. Aug. 15, 1962 96 p 213 refs
(Contract NORd-17017)
(SB-61-68; Rept. 3-80-61-43)

The references cited reflect an attempt to collect information on the natural and induced environment of a missile in midcourse flight and in reentry. Therefore, while information on the missile in the exosphere and ionosphere is included, the launch phase has been excluded. Author

N63-17734 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SPACE VEHICLE ENVIRONMENT AND SOME NASA FACILITIES FOR THEIR SIMULATION

John A. Duberg Repr. from Shock, Vibration and Associated Environments, Pt. II, Bull. 31, Mar. 1963 p 12-24

In this brief look at some of the important problems arising from space-vehicle-system environments, it is convenient to regard them in three phases: the launch phase, in which most of the problems are associated with the dynamic response of the vehicle to engine and aerodynamic inputs; a space phase, in which the problems are associated with the radiation and meteoroid particles that the earth's atmosphere and magnetic field have protected us from; the atmospheric reentry phase, in which the major problem is that of dissipating the tremendous kinetic energy of the vehicle by means which will reduce the heat input to the surface to tolerable levels. Author

N63-17804 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

VEHICLE SYSTEM EFFECTS ON LARGE SOLID MOTOR DESIGN

Joe K. Pinkston N.Y., AIAA [1963] 9 p Presented at the AIAA Summer Meeting, Los Angeles, June 17-30, 1963
(AIAA Paper 63-260) AIAA: $0.50 members, $1.00 nonmembers

The working relationship between engine and space vehicle designs is examined to find that the systems and engine designers must possess a working knowledge of each other's field in order to design an integrated vehicle from the start. The upper stages and payload of a vehicle are found to place impulse, thrust, thrust vacuum, and propellant and motor weight requirements on the engines. The vehicle has certain performance requirements-lift-off and maximum acceleration requirements, maximum and staging dynamic pressures, a thrust curve profile, separation requirements, a trajectory profile, and launch location and direction requirements—which must be met. There are requirements for thrust vector control—the guidance and control duty cycle, nozzle type, cant angle, and expansion ratio. Other factors are: the flexibility of the basic design, launch operations, the ignition system, available propellants, and the manufacturing process. All of these factors must be considered in the design of solid propellant rocket engines for large space vehicles, and in the decision as to which available engine to use with new vehicle systems. D.E.R.

N63-17808 Douglas Aircraft Co., Inc., Santa Monica, Calif.

ROMBUS—AN INTEGRATED SYSTEMS CONCEPT FOR A REUSABLE ORBITAL MODULE (BOOSTER AND UTILITY SHUTTLE)

Philip Bono N.Y., AIAA [1963] 23 p 11 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17-20, 1963
(Sponsored by NASA)
(AIAA Paper 63-271) AIAA: $0.50 members, $1.00 nonmembers

The objective of this paper is to define a conceptual design for a reusable surface-to-orbit manned cargo carrier which can deliver a payload of many hundreds of tons to a 175-nautical-mile orbital altitude. Recovery is accomplished by deployment of a subsonic drag device and terminal retrothrust. Touchdown on land is implemented by settling on four extensible legs, in a manner similar to the basic method which is being developed for landing on the moon. Author

N63-17920 Rocketdyne, Canoga Park, Calif.

ANALYTIC DETERMINATION OF THRUST LEVEL AND IMPULSE REQUIREMENTS FOR SPACECRAFT ON-OFF JET ATTITUDE CONTROL SYSTEMS

V. E. Haloulakos N.Y., AIAA, [1963] 26 p 11 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17-20, 1963
(NASA Contract NAS7-88)
(AIAA Paper 63-237) AIAA: $0.50 members, $1.00 nonmembers

The fundamental aspects of the spacecraft attitude-control problem are discussed in terms of individual maneuvers and overall mission requirements. Specifically, the analysis is applied to determining the overall impulse and propellant requirements for sample vehicles and missions, and also for precisely calculating the required thrust levels. The required thrust level is found to be a function of the propellant used; three distinct thrust levels result when cold gas, hypergolic bipropellant, or monopropellant (using catalytic packs for initiating and sustaining combustion) are compared on the basis of identical impulse requirements. Vehicles weighing 5000, 50,000, and 500,000 pounds were considered, and the thrust and total impulse attitude-control requirements for Mars and Venus transfer missions were evaluated. The control-system functions analyzed consist of initial vehicle orientation, occasional reorientation and position stabilization during the coast phase, and the midcourse-correction propulsive maneuvers. The final results indicate that a single all-jet attitude-control system can satisfactorily perform the required tasks, and furthermore that the uniquely defined thrust levels and the associated propellant consumption are low. Author

N63-17922 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

DYNAMIC TESTING OF THE OAO STABILIZATION AND CONTROL SUBSYSTEM

D. A. Imgram and W. K. Muench (Grumman Aircraft Eng. Corp.), and L. Rabb N.Y., AIAA [1963] 15 p 4 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17-20, 1963
(AIAA Paper 63-176) AIAA: $0.50 members, $1.00 nonmembers

Facilities employed to dynamically test the stabilization and control subsystem of the Orbiting Astronomical Observatory (OAO), the types of tests conducted, and test results are described. Specifically treated is the Dynamic Test Facility, the largest and most advanced of the facilities in the OAO systems. N.E.A.

N63-17967 Raytheon Co. Equipment Div., Waltham, Mass.

SPACE VEHICLE RECOVERY CONTROL SYSTEM CONCEPTS

[1962] 67 p 23 refs

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1. GROUND INSTRUMENTATION REQUIREMENTS FOR THE RECOVERY OF LIFTING RE-ENTRY VEHICLES J. Zvara and R. L. Schroeder p I-1-I-9 (For abstract see N63-17329 18-15)
2. DESIGN CONSIDERATIONS FOR THE NASA GROUND OPERATIONAL SUPPORT SYSTEM R. L. Schroeder and J. Zvara p II-1-II-8 (See N63-17968 16-30)
3. COMMUNICATION SYSTEM REQUIREMENTS FOR SPACE GCA R. L. Schroeder p III-1-III-7 (See N63-17969 16-30)
4. SYSTEMS SPECIFICATIONS OF A RECOVERY CONTROL CENTER FOR HYPERSONIC VEHICLES J. J. Fishman p IV-1-IV-9 4 refs (See N63-17970 16-30)
5. TERMINAL GUIDANCE FOR MANEUVERABLE AEROSPACE VEHICLES R. L. Schroeder and J. Zvara p V-1-V-6 4 refs (See N63-17971 16-30)
6. RE-ENTRY NAVIGATION FOR MANEUVERABLE AEROSPACE VEHICLES R. L. Schroeder and J. Zvara p VI-1-VI-6 (See N63-17972 16-30)

7. DETERMINATION OF LIFT OR DRAG PROGRAMS TO MINIMIZE RE-ENTRY HEATING A. E. Bryson, W. F. Denham, F. J. Carroll, and K. Mikami p VII-1–VII-11 11 refs (See N63-17973 16-30)
8. OPTIMUM LATERAL TURNS FOR A RE-ENTRY GLIDER A. E. Bryson, K. Mikami, and C. T. Battle p VIII-1–VIII-6 4 refs (See N63-17974 16-30)

N63-17968 Raytheon Co. Equipment Div., Waltham, Mass.
DESIGN CONSIDERATIONS FOR THE NASA GROUND OPERATIONAL SUPPORT SYSTEM
R. L. Schroeder and John Zvara *In its* Space Vehicle Recovery Control System Concepts [1962] p II-1–II-8 Submitted for Publication (See N63-17967 16-30)

A ground operational support system for real-time operational support required for Gemini, Apollo, and other manned space programs is discussed. The system will include a worldwide tracking, telemetry, and communication network. Each tracking station in the network will require a precision radar, acquisition aid, telemetry equipment, data storage media, limited data processing, monitoring consoles and displays, emergency advisory control capability, and communication equipment. All information from the network will be transmitted to an integrated mission control center that will integrate all flight operations and provide all support to the mission necessary for success. The major function of the center will be to analyze all critical flight performance data from the vehicle or tracking network; display all pertinent information to operations personnel who will perform filtering and decision functions; generate commands and also communicate with the vehicle; display pertinent ground operational support system status and performance information; control the ground operational support system, and communicate with other appropriate agencies.
C.L.W.

N63-17969 Raytheon Co. Equipment Div., Waltham, Mass.
COMMUNICATION SYSTEM REQUIREMENTS FOR SPACE GCA
Robert L. Schroeder *In its* Space Vehicle Recovery Control System Concepts [1962] p III-1–III-7 Presented at the Air Force Assoc. Annual Conv., Las Vegas, Nev., Sept. 1962 (See N63-17967 16-30)

A space, ground-controlled communication system for reentry vehicles is discussed. The major role of the ground system will be to enhance flight safety and improve flight operations. This system will utilize an operational control concept, which will exploit the vehicle maneuver capability to maximize the allowable error in time of earth return and in initial conditions to ensure a successful landing at a preselected site. The recovery concept calls for an integrated ground tracking network tied to a centralized control–decision center via a real time ground data link. C.L.W.

N63-17970 Raytheon Co. Equipment Div., Waltham, Mass.
SYSTEMS SPECIFICATIONS OF A RECOVERY CONTROL CENTER FOR HYPERSONIC VEHICLES
Jack J. Fishman *In its* Space Vehicle Recovery Control System Concepts [1962] p IV-1–IV-9 4 refs Presented at the IRE Intern. Conf., New York City, Mar.1962 (See N63-17967 16-30) (Contract AF 04(611)-5965)

This paper summarizes an unclassified portion of a recently completed study for a Recovery Control Center (RCC), which will be capable of effecting safe, routine recovery of manned hypersonic vehicles employing aerodynamic control. A number of critical areas are pointed out which must be considered in the design of such a center. Author

N63-17971 Raytheon Co. Equipment Div., Waltham, Mass.
TERMINAL GUIDANCE FOR MANEUVERABLE AEROSPACE VEHICLES
Robert L. Schroeder and John Zvara *In its* Space Vehicle Recovery Control System Concepts [1962] p V-1–V-6, 4 refs Publ. in Space/Aeronautics, July 1962 (See N63-17967 16-30)

Spacecraft of the future will require a well-integrated onboard and ground-based energy-management system in the terminal region of flight. The ground-based system will assist the pilot in normal recovery operations in ideal weather conditions. Since such ideal conditions will rarely exist, the operational requirements for terminal navigation for future space programs will require that the spacecraft be guided to touchdown reliably, under a wide variety of contingency situations, environmental variations, and physical and psychological constraints. Under these conditions, a ground complex to monitor, assist, and, in some cases, command control the terminal portion of the recovery process will be mandatory to ensure a high probability of successful recovery. Any terminal navigation system must be closely integrated into the total recovery system for maximum effectiveness. Author

N63-17972 Raytheon Co. Equipment Div., Waltham, Mass.
RE-ENTRY NAVIGATION FOR MANEUVERABLE AEROSPACE VEHICLES
Robert L. Schroeder and John Zvara *In its* Space Vehicle Recovery Control System Concepts [1962] p VI-1–V-6 Publ. in Space/Aeronautics, Sept. 1962 (See N63-17967 16-30)

Future space operations will require a recovery control system to bring maneuverable spacecraft to a landing at a designated point on the earth's surface with a maximum probability of success. Combinations of airborne and ground instrumentation will be most effective. A centralized recovery control system with adequate data transmission and computing capacity, in conjunction with an integrated tracking network, is both feasible and necessary to assist in the recovery of advanced space vehicles with an acceptable probability of success. During normal flights under ideal environmental conditions, when all onboard equipment functions properly, the ground system will monitor the progress of the flight, interpret flight data, and assist and backup the pilot in making a successful recovery. In the event of pilot incapacities, failures of onboard instrumentation, abnormal reentry conditions, or adverse environmental conditions, the ground system will be necessary to assist the pilot, or perhaps assume command control of the vehicle for the remainder of the recovery operation. A ground flight controller will be in constant two-way voice communication with the pilot, and will assist him in a manner similar to a GCA operator "talking down" a conventional aircraft today. The approach, however, will extend over a substantial portion of the globe. To provide this type of real-time support for recovery operations of maneuverable hypersonic vehicles involves computations and control problems far more complex than those developed for recovery of ballistic reentry vehicles. Author

N63-17973 Raytheon Co. Equipment Div., Waltham, Mass.
DETERMINATION OF LIFT OR DRAG PROGRAMS TO MINIMIZE RE-ENTRY HEATING
Arthur E. Bryson, Walter F. Denham, Frank J. Carroll, and Kinya Mikami *In its* Space Vehicle Recovery Control System Concepts [1962] p VII-1–VII-11 11 refs Presented at the Space Flight Mechanics Session, IAS Annual Meeting, New York, Jan. 1961 (See N63-17967 16-30)

A study of single-pass reentry from escape speed and from circular satellite speed is made to determine the lift program for a hypersonic glider and the drag-modulation program for a nonlifting vehicle that minimize the heating of the vehicles within acceleration or range constraints. A new method of numerical solution is used, similar to Kelley's "method of gradients," that permits rapid convergence to the optimum lift program, starting with an original good estimate. This method avoids the two-point boundary-value problem of the calculus-of-variations formulation, and is applicable to any optimum-programing problem. An acceleration-tolerance limit is introduced which describes the human pilot's capability to withstand acceleration more accurately than a simple acceleration limit. Author

N63-17974 Raytheon Co. Equipment Div., Waltham, Mass.
OPTIMUM LATERAL TURNS FOR A RE-ENTRY GLIDER
Arthur E. Bryson, Kinya Mikami, and C. Tucker Battle *In its* Space Vehicle Recovery Control Systems Concepts [1962] p VIII-1–VIII-6 4 refs Presented at the IAS 30th Annual Meeting, New York City, Jan. 1962 (See N63-17967 16-30) (Contract AF 33(616)-8300)

Simultaneous angle-of-attack and bank-angle programs are determined for a lifting reentry vehicle to produce maximum lateral offset from an initial great-circle plane within range, heat, and acceleration constraints. The vehicle is treated as a particle, and the earth is approximated as an oblate-spheroid with an ARDC model atmosphere rotating with the earth. Only coordinated turns are considered (no side-slip). Optimum programs are determined using the steepest-ascent method previously developed by the authors. A numerical example is given for reentry from subcircular speed for a representative vehicle. Author

N63-17992 National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.
WIND-TUNNEL INVESTIGATION OF STATIC AERODYNAMIC CHARACTERISTICS OF A 1/9-SCALE MODEL OF A POSSIBLE REENTRY CAPSULE AT MACH NUMBERS FROM 2.29 TO 4.65
David S. Shaw and Kenneth L. Turner Washington, NASA, Dec. 1959 20 p 1 ref
(NASA TM X-233) OTS: $1.60 ph, $0.80 mf (Declassified)

An investigation has been conducted in the Langley Unitary Plan wind tunnel to determine the static aerodynamic characteristics of a 1/9-scale model of a possible reentry capsule. Tests were performed both with and without an escape system attached to the exit face; two spherical-segment reentry faces (faces I and II) were also included as part of the investigation. Tests were performed at angles-of-attack from −4° to 184° and at Mach numbers from 2.29 to 4.65. The Reynolds numbers per foot varied from about 2.3×10^6 to 3.0×10^6. The results show that the escape configuration trims with positive stability at an angle-of-attack near 180° (exit face forward) for all test Mach numbers. The capsule with face I and the capsule with face II both trim with positive stability near an angle-of-attack of 0° (reentry face forward). At Mach numbers of 4.65 and 3.94, however, the capsules are neutrally stable near an angle-of-attack of 180°. This condition is undesirable, and proper precautions should be taken to ensure a satisfactory margin of instability for the configurations in this attitude. Author

N63-17994 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PRESSURE DISTRIBUTION ON TWO MODELS OF A PROJECT MERCURY CAPSULE FOR A MACH NUMBER RANGE OF 1.60 TO 6.01 AND AN ANGLE-OF-ATTACK RANGE OF 0° TO 180°
Robert A. Newlander, Nancy L. Taylor, and E. Brian Pritchard Washington, NASA, Nov. 1960 97 p 3 refs
(NASA TM X-336) OTS: $8.60 ph, $2.81 mf (Declassified)

The complete pressure distribution on a 1/9-scale model of the Project Mercury capsule was determined for a Mach number range of 1.60 to 4.65, Reynolds numbers from 2.05×10^6 to 2.68×10^6, and an angle-of-attack range from 0° to 180°. A 1/14.9-scale model was tested at a Mach number of 6.01, a Reynolds number of 2.52×10^6, and an angle-of-attack range from 0° to 30°. Newtonian theory for the prediction of pressure coefficients on a spherical body was found to be applicable to the ablation shield for the reentry configuration. Author

N63-17995 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DYNAMIC STABILITY AND DISPERSION OF A PROJECT MERCURY TEST CAPSULE UPON ENTERING THE ATMOSPHERE, WITH EFFECT OF ROLL RATE, CENTER-OF-GRAVITY DISPLACEMENT, AND THRESHOLD OF A RATE-REACTION CONTROL SYSTEM
Byron M. Jaquet Washington, NASA, Jan. 1961 79 p 5 refs
(NASA TM X-350) OTS: $7.60 ph, $2.57 mf (Declassified)

Results are presented on an analytical investigation of the effects on the dynamic stability of a Project Mercury test capsule during reentry from a 450,000-foot altitude. The dispersion area at a Mach number of 1.0, the point of first parachute deployment, was also determined. In addition, calculations were made at six altitudes to determine the capability of the control system to compensate for arbitrarily imposed step disturbances in angle-of-attack and in the pitch and yaw rates. All calculations were made on an IBM-704 electronic data-processing machine for a spherical nonrotating earth. Author

N63-18038 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC LONGITUDINAL CHARACTERISTICS OF SEVERAL PROJECT MERCURY LAUNCH VEHICLES AT MACH NUMBERS BETWEEN 0.4 AND 6.8
James D. Church, Albin O. Pearson, and Peter J. Bernot Washington, NASA, Feb. 1961 49 p 3 refs
(NASA TM X-433) OTS: $4.60 ph, $1.67 mf (Declassified)

An investigation has been conducted in various wind tunnels at the Langley Research Center to determine the static longitudinal stability characteristics of some Project Mercury booster-capsule configurations. Data were obtained for models of the Little Joe, Redstone-Mercury, and Jupiter-Mercury configurations with the various capsule arrangements suitable to these particular vehicles over a Mach-number range of 0.4 to 6.8, and a maximum angle-of-attack range from approximately −14° to 18°. Brief comments on the significance of the model stability data, with respect to proposed full-scale flight, are presented. Author

N63-18040 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DYNAMIC MODEL TESTS AT LOW SUBSONIC SPEEDS OF PROJECT MERCURY CAPSULE CONFIGURATIONS WITH AND WITHOUT DROGUE PARACHUTES
James S. Bowman, Jr. Washington, NASA, Feb. 1961 22 p 3 refs
(NASA TM X-459) OTS: $2.60 ph, $0.80 mf (Declassified)

An investigation has been conducted at low subsonic speeds in the Langley 20-foot free-spinning tunnel to determine the effectiveness of several sizes of drogue parachutes in stabilizing a Mercury capsule of the NASA and McDonnell designs, and to determine the dynamic stability of the capsule with and without the escape tower. In addition, tests were made to determine the effects of high rotational rates of the capsule about the symmetrical axis while in vertical descent with the drogue parachute attached. Model test results indicate that in order to insure adequate stability for the capsule descending vertically at low subsonic speeds, a stable drogue parachute having a 6-foot diameter (laid-out-flat) would be required. The drogue parachute is attached to the capsule with a 45-foot (full-scale) towline at three equally spaced points around the periphery of the antenna housing by a bridle 10 feet (full scale) in length. Author

N63-18071 RAND Corp., Santa Monica, Calif.

THE APPLICATION OF DYNAMIC PROGRAMMING TO SATELLITE INTERCEPT AND RENDEZVOUS PROBLEMS

F. T. Smith Dec. 1962 17 p 4 refs

The two-body equations-of-motion for the target vehicle and interceptor are linearized, and a quadratic performance index is defined. Idealized performance of the terminal guidance process consists of reducing the relative position between the target and interceptor to zero for the intercept case, and relative position and velocity to zero for the rendezvous case. The explicit expressions for the optimal control vector to minimize the performance index are given. Idealized observational instrumentation, i.e., perfect measurements of relative position and velocity, made from the interceptor are assumed. Author

N63-18132 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ARREST OF A MOVING MASS BY AN ATTACHED MEMBRANE

Manuel Stein Washington, NASA, July 1963 14 p
(NASA TN D-1928) OTS: $0.50

Large-deflection solutions are obtained for a fixed-end membrane strip and for a fixed circular membrane, each with a centrally located attached mass initially moving at a given speed. The solutions are given in the form of equations and curves for the deflections and stresses. Author

N63-18188 General Dynamics/Convair, San Diego, Calif.

LITTLE JOE II LAUNCHER UMBILICAL RETRACTION TEST. MODEL 12

D. A. Fletcher June 26, 1963 13 p
(Contract CPO-62-323)
(SL-63-033)

The Little Joe II Launcher umbilical plug and retraction boom have been tested under simulated launching conditions. The results of these tests indicate satisfactory operation of the umbilical retraction system. R.C.M.

N63-18203 Applied Physics Lab., Johns Hopkins U., Silver Spring, Md.

DYNAMIC ANALYSIS OF GRAVITY GRADIENT SATELLITE WITH PASSIVE DAMPING

J. L. Vanderslice June 1963 46 p
(TG-502)

A dynamic analysis is presented of a gravity-gradient earth satellite in circular orbit that is equipped with devices for passively damping spin and libration. The gravity gradient configuration considered consists of a rigid boom projecting from the main satellite body along one of the principal axes. A lossy helical spring is attached to the far end of the boom and carries a small mass at its free end. The purpose of the spring is to provide damping of satellite libration through energy dissipation. Two sets of despin rods, having high magnetic hysteresis loss, are rigidly attached within the satellite at right angles to each other and to the boom axis. The purpose of the rods is to remove spin and any libration not controlled by the spring by means of hysteresis losses induced by rod motion in the earth's magnetic field. Altogether, seven degrees of freedom are involved, including wind-up angle in the spring. In the analysis, the satellite is not assumed to be symmetric about the spin axis. The energy functions and the magnetic torques are derived, and Lagrange's equations are used to set up the seven differential equations of the system. Using various simplifying assumptions, the equations are used to deduce a number of results, such as frequency and damping of normal modes, time constants of libration decay, steady-state behavior, initial offset due to spin, and effect of orbital eccentricity. The results of a digital simulation are in virtually full agreement with the theoretical analysis, and no cases of undesirable behavior which could not be eliminated by adjustment of parameters were found. M.P.G.

N63-18210 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FLIGHT TEST OF A PITCH CONTROL FOR A SPINNING VEHICLE

H. D. Garner and H. J. E. Reid, Jr. Washington, NASA, July 1963 14 p refs
(NASA TN D-1922) OTS: $0.50

A flight test was made of a simple single-axis attitude-control system for the fourth stage of a spin-stabilized vehicle. The system utilized two body-fixed horizon detectors for attitude sensors, a single rate gyro for stability augmentation, and a single jet for control. It weighed less than 18 pounds, including batteries and control-jet gas. Flight results showed the attitude error to be less than ±1/2°, and the coning angle to be less than ±2° throughout the test period. Very close correlation was obtained between actual flight-test results and preflight computer studies. Author

31 SPACE VEHICLES (LAUNCH VEHICLES)

Includes: boosters; clustered rockets; and multistage rockets.

For propulsion engines see: 27 Propulsion.

For launch vehicle - spacecraft combinations see: 30 Space Vehicles.

For related information see: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

N63-17660 General Dynamics/Astronautics, Cocoa Beach, Fla.

CHECKOUT OF MERCURY-ATLAS LAUNCH VEHICLES

C. D. Fowler N.Y., AIAA [1963] 15 p Presented at the AIAA Space Flight Testing Conf., Cocoa Beach, Fla., Mar. 18–20, 1963
(Sponsored by NASA)
(AIAA Paper 63070) AIAA: $0.50 members, $1.00 nonmembers

A description is given of the Atlas in its original configuration and the changes necessary for use as a Mercury booster. The Abort Sensing and Implementation System (ASIS) was added to trigger the escape mechanism prior to a catastrophic failure and is described. The parameters monitored by the ASIS are listed and discussed. The test program described is basically limited to checkout at AMR. The flight testing at AMR consists of unloading the airplane, laboratory checks, erection of the launch vehicle on the test stand, system checkout, tanking test, Flight Acceptance Composite Test (FACT), spacecraft mate and joint test between spacecraft and launch vehicle. A bar chart of the MA-8 countdown is included for reference. Author

N63-17801 Lockheed Missiles and Space Co., Palo Alto, Calif.

SIZING OF NUCLEAR ORBIT LAUNCH VEHICLES FOR INTERPLANETARY MISSIONS

John F. Mc Laughlin N.Y., AIAA [1963] 12 p 9 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963 (NASA Contract NAS8-5024)

(AIAA Paper 63-256) AIAA: $0.50 members, $1.00 non-members

An analysis of the sizing requirements of nuclear orbit launch boosters for interplanetary round trip flyby and stopover missions is presented. The requirements for four power levels are specified for two types of Mars "lighted-side" flybys for 1971, 1973, 1975, 1988 and 1990; for Venus lighted-side flybys during any conjunction period; for a two-planet flyby in 1972; and for some stopover missions. In addition, these requirements are matched with the estimated capabilities of a presently conceived operational nuclear stage and with the launching capabilities of the Saturn V. Author

N63-18099 Directorate of Research Analyses, Holloman AFB, N. Mex.

A PROPOSED IMPROVEMENT IN OPTIMIZATION TECHNIQUE FOR N-STAGE ROCKETS

H. Palmer Hotz (Okla. State U.) and A. V. Houghton III (N. Mex. U.) July 1962 48 p 21 refs

(AFOSR/DRA-62-14)

In the design of multistaged rockets, an essential feature is the optimization of the stages. This report is a comparison of the methods of Weisbord and Schurmann, and the derivation of a new optimization procedure based on the energy rather than upon velocity. The numerical results of this method are compared with those of the earlier papers, and it is shown that higher payload energies may be obtained for a given expenditure of fuel when the method of this report is used. Author

N63-18155 Aeronautical Systems Div. Flight Control Lab., Wright-Patterson AFB, Ohio

FURTHER INVESTIGATION OF ELASTIC MODE EFFECTS ON CLOSED LOOP STABILITY OF A WINGED BOOSTER [Final Report No. 3]

Robert L. Swaim [Mar. 1963] 39 p 2 refs

(ASRMCM-TM-63-1)

This report concerns a closed-loop analysis of the dynamic interaction of elastic- and rigid-body modes for a large booster in the ORION class. A variety of possible first and second elastic-mode shapes is assumed along with three different sensor locations. Closed-loop dynamics are determined for all combinations of these conditions and for a wide variation in autopilot, actuator, and rate gyro gains. The interaction is shown to be very severe on both the short-period and elastic modes. For all cases considered, regardless of the gains used, the real roots corresponding to the first-order actuator and rate gyro time constants were positive, indicating instabilities. It is also shown analytically that there is no combination of actuator, autopilot, and gyro gains which would stabilize the stated system. In addition, the short-period characteristics are very insensitive to orders-of-magnitude variations in system gains. These surprising results mean that conventional sensing and feedback control with single actuation would not be suitable for this vehicle. Author

32 SPACE VEHICLES (SPACECRAFT)

Includes: manned space capsules; satellites; and space probes.

***For boosters and rockets see:* 31 Space Vehicles (Launch Vehicles).**

***For Launch vehicle—spacecraft combinations see:* 30 Space Vehicles.**

***For related information see:* 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.**

N63-17504 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

SOME CONTROL PROBLEMS ASSOCIATED WITH EARTH-ORIENTED SATELLITES

Vernon K. Merrick Washington, NASA, June 1963 81 p 3 refs (NASA TN D-1771) OTS: $2.00

A stability and control analysis is made of a class of inertia-wheel-controlled earth satellites whose orientation is controlled relative to a set of orthogonal axes, two of which are the local earth vertical and the normal to the orbital plane. The NASA Nimbus meteorological satellite is a typical example. It is demonstrated for a restricted but nevertheless important subclass of these satellites, defined by a particular inertia distribution, that the stability about the local earth vertical (yaw) and the stability of the vehicle angular momentum are independent of each other. This fact is used to extract many fundamental dynamical properties of the system, in particular, the influence, on stability, of the orientation and time constant of the yaw-sensing gyro. Furthermore, the analysis gives some insight into the role of gravity torques and into the inherent difficulties involved in the removal of angular momentum from the vehicle. Performance data for a satellite similar to Nimbus, obtained from digital and analog studies, are used to supplement the stability analysis and to demonstrate transient responses following control commands. Author

N63-17518 McDonnell Aircraft Corp., St. Louis, Mo.

MERCURY SPACECRAFT PRE-LAUNCH PREPARATIONS. PART I: AT THE MANUFACTURER'S PLANT

Anthony P. Anderhub and Tony Pandolfi N.Y., AIAA [1963] 28 p Presented at the AIAA Space Flight Testing Conf., Cocoa Beach, Fla., Mar. 18–20, 1963

(AIAA Paper 63071) AIAA: $0.50 members, $1.00 non-members

The Production Mercury Spacecraft preflight test program was performed in two phases: manufacturer predelivery acceptance tests and the preflight tests performed at Cape Canaveral. Tests were performed at the McDonnell facility principally to evaluate the spacecraft systems performance and demonstrate that each spacecraft performed to spacecraft specifications prior to acceptance by NASA. Author

N63-17519 National Aeronautics and Space Administration. Manned Spacecraft Center, Cape Canaveral, Fla.

MERCURY SPACECRAFT PRE-LAUNCH PREPARATIONS. PART II—AT THE LAUNCH SITE

John J. Williams and Donald M. Corcoran N.Y., AIAA [1963] 49 p 2 refs Presented at AIAA Space Flight Testing Conf., Cocoa Beach, Fla., Mar. 18–20, 1963

(AIAA Paper 63072) AIAA: $0.50 members, $1.00 non-members

This paper presents the checkout philosophies and procedures employed during the preflight checkout of a Mercury spacecraft at Cape Canaveral. It explains the purpose of the various tests and techniques used in the checkout of the spacecraft at Hangar "S" test complex and at the launch complex. Test flow diagrams are presented to illustrate the building-block approach for determining the integrity of Mercury spacecraft prior to launch. Author

N63-17547 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ON THE MOTION OF A 24-HOUR SATELLITE
Peter Musen and Ann E. Bailie Washington, NASA, June 1963 23 p 5 refs Previously announced as a preprint. see N62-11758 06-31
(NASA TN D-1750) OTS: $0.75

The theory and conditions for stability of a satellite with a 24-hour period are given. Bohlin's resonance theory was applied to obtain the solution. It is shown that the integrals of the problem can be represented in series form, with respect to the small parameter w, which is proportional to the mean motion of the critical argument in a nonresonance case. Expressions for the period of libration, and the mean motion of the critical argument in the unstable case are also given. A system of formulas is presented which can be used to compute any particular case. Author

N63-17706 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
THE ELECTRIC SPACE CRUISER FOR HIGH ENERGY MISSIONS
Robert J. Beale, Evelyn W. Speiser, and James R. Womack N.Y., AIAA [1963] 12 p 8 refs Presented at the AIAA Electric Propulsion Conf., Colorado Springs, Mar. 11–13, 1963
(NASA Contract NAS7-100)
(AIAA Paper 63007-63) AIAA: $0.50 members, $1.00 nonmembers

A basic spacecraft capable of significant, unmanned exploration of the entire solar system can be achieved by the use of a modest nuclear-electric propulsion system employing a Saturn-B booster chain. Within a 1-yr flight time, the spacecraft would be able to explore the near-Earth region of the solar system. With an ultimate 2-yr propulsion-system-lifetime goal, the spacecraft would be able to orbit Jupiter and to probe the remainder of the solar system. Basic system requirements for this type of vehicle are thrust devices efficient in the specific impulse range of 6000 to 12,000 sec, a nuclear turboelectric powerplant of 500 kwe, weighing about 14 lb/kw, and a total spacecraft weight of 20,000 lb. A brief systems description of the spacecraft is presented. For discussion purposes, a Jupiter orbiter mission is used as an example. The modes of operation for the spacecraft are reviewed and a summary of major subsystem weights is shown. Other study areas explored and reported indicate a typical power profile for the mission, micrometeoroid armor requirements, the effect of nuclear shielding tradeoffs, and the major factors determining the selection of the optimum power level. Author

N63-17743 National Aeronautics and Space Administration, Washington, D.C.
MERCURY-ATLAS 9 PRESS KIT News Release No. 63-90
May 10, 1963 71 p
Available from NASA. Office of Scientific and Technical Information, Wash., D.C.

Preparations for the sixth U.S. manned spaceflight (MA-9) are described. This flight, with Astronaut L. Gordon Cooper at the controls, was planned to meet one of the original objectives of the Mercury program, manned one-day spaceflight. The experiments scheduled during the MA-9 mission include: aeromedical studies, flashing beacon experiment, dim light phenomenon photographs, horizon definition experiments, radiation measurements, tethered balloon experiment, infrared weather photographs, television system operation, cabin environmental temperature study, HF antenna test, ground light experiment, window attenuation evaluation, and white paint reentry temperature experiment. Spacecraft systems, prelaunch operations, powered flight and orbital events schedules, and recovery preparations are also described. M.P.G.

N63-17758 National Aeronautics and Space Administration, Washington, D.C.
COMMUNICATIONS SATELLITES News Release
Leonard Jaffe Presented at the First World Conf. on World Peace Through Law, Athens, Greece, June 30–July 7, 1963 32 p
Available from NASA. Office of Scientific and Technical Information, Washington, D.C.

The feasibility of satellites for transoceanic communication is discussed. Both active and passive satellites are investigated, and the problems confronted by utilizing each type are presented. Echo I, Echo II, Score, Courier, Telstar, Relay, and Syncom are some of the satellites utilized in the communication experiments discussed. Passive satellites are potentially very reliable but, since they only mirror and reflect signals, they are restricted to distances less than 2000 miles from the earth and they require expensive ground stations. Active satellites have greater operating ranges since they receive, amplify, and transmit signals, but the electronic equipment carried by these satellites is extremely sensitive to radiation; exposure to the radiation in space results in shorter component operating life. C.L.W.

N63-17984 Allied Research Associates, Inc., Concord, Mass.
APT USERS' GUIDE Scientific Report No. 1
Leon Goldshlak June 1963 51 p
(Contract AF 19(628)-2471)
(ARA-T-9219-1; AFCRL-63-655)

The Nimbus meteorological satellite system will provide high-altitude pictures of the earth's atmosphere. An automatic picture-taking (APT) subsystem will permit local picture readout at those sites which have appropriate terminal equipment. This guide is intended to serve as an introduction to data-handling procedures at APT acquisition sites. Specific subjects treated in the guide are: satellite tracking, picture rectification, and geographic referencing. An appendix is included to assist personnel at the acquisition site with picture rectification problems of the experimental TIROS APT subsystem. Author

N63-18100 Royal Aircraft Establishment, Farnborough (Gt. Brit.)
BRIEF DATA ON SOVIET ARTIFICIAL EARTH SATELLITES, SPACE-SHIP SATELLITES AND SPACE ROCKETS
London Ministry of Aviation, May 1963 7 p Transl. into ENGLISH from Iskusstvennye Sputniki Zemli (Moscow), 12, 1962 p 3–5
(RAE-TRANS-1034)

Details are tabulated of launch dates, weights, orbits, and scientific experiments of the Russian satellites and space vehicles between October 1957 and April 1962. Author

33 STRESSES AND LOADS

Includes: fatigue; vibration; flutter; and structural tests.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 34 Structural Design.

N63-17493 Toronto U. Inst. of Aerophysics (Canada)

AN INVESTIGATION OF THE FATIGUE OF ALUMINUM ALLOY DUE TO RANDOM LOADING

S. R. Swanson Feb. 1963 125 p 56 refs
(Contract AF 49(638)-548)
(UTIA-84)

A study of the aluminum alloy 2024-T4 under random and constant amplitude axial-fatigue loading was undertaken using 1500 unnotched extruded bar specimens. In the constant-amplitude test series, it was discovered that the stress amplitude–endurance (S-N) relation is well represented by two separate failure distributions such that, as the stress amplitude is lowered, the one distribution recedes while the other distribution becomes predominant. The knee of the S-N curve is then considered as a transition from endurances predominantly of the one distribution to endurances predominantly of the other. A significant observation from the random load tests has been the appearance of visible secondary cracks on the unnotched axially loaded specimens. Author

N63-17554 General Electric Co., Cincinnati, Ohio

HIGH-TEMPERATURE MATERIALS PROGRAM Progress Report No. 23, Part A

May 31, 1963 37 p 4 refs
(Contract AT(40-1)-2847)
(GEMP-23A; Progress Rept. 23, Pt. A) OTS: $1.00

Stress-rupture tests comparing sintered and arc-cast molybdenum at 2200° C furnished additional evidence that the previously discussed Mo-A material is a powder-metallurgy-sintered product and that Mo-B and Mo-C are arc-cast materials. The stress-rupture and creep testing of tungsten was initiated. Tests were performed at 1600°, 2400°, and 2800° C for rupture times up to 12 hours. The test results of two sources of sintered tungsten indicate that the strength and creep characteristics of the material are dependent on the source. The stress-rupture testing of tantalum was continued with the emphasis on the effect of contaminants in the test atmosphere. As expected, the stress-rupture tests confirmed that this material is much more susceptible to contamination at temperatures of 2400° to 2600° C than the other refractory materials tested. The preliminary screening of brazing alloys for tantalum was completed. The major evaluation was performed on braze alloys from the Nb-Ta-V ternary system. The advantages of alloys from this system are: (1) These alloys are suitable for brazing temperatures between 1950° and 2400° C. (2) No intermediate phases are present in the alloys or in the diffusion products formed by the alloys. (3) Erosion of the base metal from the liquid braze alloys is considered minimal for this time exposure, ranging from 0 to 0.005 inch during the braze cycle. (4) Increase in remelt temperature of the braze joint by diffusion is comparatively rapid. (5) The alloys can be applied to the braze joint by standard sheet, wire, and powder techniques. Author

N63-17604 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.

THEORETICAL INVESTIGATION OF THE FLUTTER CHARACTERISTICS OF A JET–FLAP HELICOPTER ROTOR IN HOVERING AND FORWARD FLIGHT Technical Report [Nov. 1961–Nov. 1962]

Andrew R. Trenka and Richard P. White, Jr. Apr. 1963 100 p 27 refs
(Contract DA-44-177-TC-699)
(TRECOM-TR-63-9)

The purpose of the theoretical study reported herein was to investigate the aeroelastic characteristics of a jet-flap rotor system in hovering and forward flight. The jet-flap rotor configuration assumed for this study incorporated most of the general characteristics of an experimental jet-flap rotor being developed for USATRECOM by the Giravions-Dorand Company of Paris, France. The following general conclusions were drawn regarding the aeroelastic characteristics of a jet-flap rotor system in hovering and forward flight. (1) The critical rotor speed associated with the symmetric flutter modes calculated on the basis of the flapping, first flapwise bending, torsion and control flap rotational degrees of freedom was sensitive to changes in the control flap to torsional frequency ratio, blade center-of-gravity position, jet blowing and control flap damping, but was not sensitive to control flap center-of-gravity position located on the control flap chord. (2) The critical rotor speed associated with the antisymmetric flutter modes calculated on the basis of the flapping, first flapwise bending, torsion and teetering degrees of freedom was markedly insensitive to changes in the bending to torsion frequency ratio, blade center-of-gravity position, jet blowing and steady-state jet deflection angle. The addition of the swivel degree of freedom to the antisymmetric flutter modes is markedly destabilizing. (3) In the symmetric modes, the effect of increasing advance ratio is destabilizing. The advance ratio at which destabilization begins and the rate of destabilization with advance ratio are dependent upon control-flap center-of-gravity position, rotor blade center-of-gravity position, and the ratio of control flap rotation frequency to blade torsional frequency. Author

N63-17626 Toronto U. Inst. of Aerophysics (Canada)

A REVIEW OF THE THEORY OF PHOTOELASTICITY

R. C. Tennyson Dec. 1962 44 p 7 refs
(UTIA-23)

The theory of both the plane and circular polariscope employing the reflected-light technique is developed. The solution for the principal stresses using goniometric compensation in conjunction with normal and oblique incidence readings for a two-dimensional analysis is outlined in detail, with a suggested technique for plotting principal stress trajectories. Also discussed are correction factors for the preceding analysis, such as the index of refraction and the reinforcing effect of birefringent coatings. Author

N63-17637 Lockheed Missiles and Space Co., Sunnyvale, Calif.

POST-BUCKLING BEHAVIOR OF STIFFENED CYLINDERS AND CURVED PANELS: AN ANNOTATED BIBLIOGRAPHY [Period Covered, 1950–June 1962]

Charlie M. Pierce comp. Sept. 1962 16 p 42 refs
(SB-62-37; Rept. 3-77-62-22)

Methods of evaluating the stability of stiffened panels and shells are of great importance in situations where a high-strength-to-low-weight ratio must be maintained. The 42 references which have been selected on this topic were chosen with emphasis on the estimation of postbuckling tendencies of stiffened structures. Author

N63-17663 Harvard U. Div. of Engineering and Applied Physics, Cambridge

UNSYMMETRICAL BUCKLING OF THIN SHALLOW SPHERICAL SHELLS

Nai-Chien Huang Mar. 1963 44 p 14 refs
(Contract Nonr-1866(02))
(Tech. Rept. 15)

A theoretical study of unsymmetrical buckling in thin shallow spherical shells under uniform external pressure is presented. Shells deform axisymmetrically under low pressure, and at maximum pressure axisymmetrical snapping occurs. The shells may snap through under the critical pressure for unsymmetrical buckling if the tangent of the branch on the pressure deflection curve has a negative slope at that critical pressure. If that branch has a positive slope, deformation of the shells changes suddenly from the axisymmetrical type to the unsymmetrical type under critical pressure but no snapping occurs. Buckling pressures obtained by numerical methods were found to be higher than those obtained from the experiment. Initial imperfections of the shells and unsymmetrical buckling are presumed to be the sources of this discrepancy between axisymmetrical buckling theory and experiment. C.L.W.

N63-17671 Grumman Aircraft Engineering Corp., Bethpage, N.Y.
STRESS DISTRIBUTION AROUND PERIODICALLY SPACED HOLES IN A SPHERICAL MEMBRANE SHELL UNDER UNIFORM INTERNAL PRESSURE
J. B. Mahoney and V. L. Salerno Mar. 1963 69 p 6 refs
(RE-163)

A method for analyzing a spherical shell supporting a constant, uniform, internal pressure with axisymmetric circular openings has been developed. The method of solution is based on shell-membrane theory and, consequently, permits only one of the two boundary conditions on the edges of the circular openings to be satisfied. This is acceptable engineering practice if the edges of the openings are stiffened. Author

N63-17680 Aberdeen Proving Ground. Ballistic Research Labs., Md.
ELASTIC RESPONSE TO BLAST LOADING OF STRAIN-RATE DEPENDENT CANTILEVERS
W. E. Baker, J. W. Hanna, and B. J. Lindenberger Nov. 1962 35 p 6 refs
(BRL-1179)

In a previous study, results were presented of a series of experiments designed to test the geometrical scaling hypothesis for structural elements which undergo both very large elastic and plastic deformations as a result of blast loading. The experimental results verified the hypothesis. The present report is an extension of the study (elastic phase only) to two plastic materials. It is concluded that one of the materials tested is probably not strain-rate dependent, but that the other is. For the latter material, the geometrical scaling hypothesis is inapplicable. Author

N63-17692 Aberdeen Proving Ground. Ballistic Research Labs., Md.
THE RESPONSE OF CYLINDRICAL SHELLS TO EXTERNAL BLAST LOADING
William J. Schuman, Jr. Mar. 1963 166 p 10 refs
(BRL Memo-1461)

A method of predicting permanent deformation of thin-walled unstiffened cylindrical shells to external blast loading from charges of high explosives is presented. Empirical relations are derived from a series of firings conducted at Aberdeen Proving Ground against scaled shells. The average deviation between the predicted and the actual blast pressures required for permanent deformation is 12%. Author

N63-17712 Syracuse U. Research Inst., N.Y.
DEFORMATIONS AND STABILITY OF SPHERICAL SHELLS SUBJECTED TO THE ACTION OF THE SYSTEMS OF LINE LOADS AND CONCENTRATED LOADS Technical Report No. 5, June 1-Sept. 11, 1962
R. M. Evan-Iwanowski and T. C. Loo [1962] 51 p 20 refs
(GRANT DA-31-124-61-G24)
(SURI-TR-834-5; AROD-2465-7)

Series of tests were performed on spherical shells subjected to the system of loadings consisting of two normal concentrated loads and line loads in the forms of rings. A phenomenon consisting of snap buckling of the portions of the shells between two loads or inside of the ring loads has been observed. Such phenomenon is called local buckling since only a portion of shell snaps without considerably effecting the rest of the shell. Pertinent data are also obtained on critical loads and deformations which may serve as design data. Author

N63-17721 General Dynamics/Astronautics, San Diego, Calif.
AN INTRODUCTION TO CRACK PROPAGATION IN HIGH STRENGTH SHEET MATERIALS
W. E. Witzell Feb. 2, 1962 12 p 7 refs
(MRG-286)

A discussion is presented of fracture mechanics, and of the theory and test methods underlying tests which have been developed to evaluate the fracture toughness of sheet alloys. Procedures have been devised for conducting fracture-toughness tests at cryogenic temperatures, and quantitative data have been developed for cold-rolled Type 301 stainless-steel sheet. The fracture toughness of this alloy at low temperatures decreases with increasing room-temperature strength (achieved by cold working) above approximately 160,000 to 170,000 psi yield strength. Also, the fracture toughness in the transverse direction is significantly less than that in the longitudinal direction at subzero temperatures. Author

N63-17795 Firestone Flight Sciences Lab., Calif. Inst. of Tech., Pasadena
THE STRUCTURAL ANALYSIS OF VISCOELASTIC MATERIALS
M. L. Williams N.Y., AIAA [1963] 44 p 81 refs Presented at the AIAA Summer Meeting, Los Angeles, Calif., June 17-20, 1963
(Supported by NASA)
(AIAA paper 63-284) AIAA: $0.50 members, $1.00 nonmembers

This paper presents a summary of methods of material characterization especially in terms of the broadband responses of the relaxation moduli and creep compliances as a function of reduced strain rate; second, as most stress analyses of linear viscoelastic materials have been based upon the "correspondence rule" relating to an associated elastic problem obtained by Laplace transformation, the alternative of exact and approximate inversion techniques is explored. It is shown that before the viscoelastic solution can be computed, the elastic one for the given geometry is required, although it may be in either analytical or numerical form, as for example from a digital computing program; third, as structural integrity in general requires the determination of failure under combined loading conditions, it is necessary to measure the strength of viscoelastic materials under various multiaxial stress states, and preferably relate it to uniaxial behavior in a manner similar to, say, the octahedral stress criterion used in metals, and taking due account of strain rate effects. Various tests for obtaining such data are described and compared. Finally, some general remarks and observations are noted as a possible basis for continuing development in techniques for engineering viscoelastic analysis. Author

N63-17815 Advisory Group for Aeronautical Research and Development, Paris (France)
MANUAL ON AEROELASTICITY. PART IV: EXPERIMENTAL METHODS
W. P. Jones, ed. (Natl. Phys. Lab., Gt. Brit.) London, Tech. Editing and Reproduction Ltd. [1960] 322 p 218 refs For Part II see N62-10906 03-05; For Part V see N63-14113 09-01

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10. FLIGHT FLUTTER TESTS M. O. W. Wolfe and W. T. Kirby (RAE. Farnborough, Gt. Brit.) p 293–322 18 refs (See N63-17825 16-33)

N63-17817 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

MEASUREMENT OF STRUCTURAL INFLUENCE COEFFICIENTS

Dennis J. Martin and William T. Lauten, Jr. *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Elasticity. Part IV: Experimental Methods [1960] p 61–92 46 refs (See N63-17815 16-33)

Experimental methods, based on the concept of structural influence coefficients, are used to determine the elastic properties of aircraft structures. An influence coefficient relates the linear deflection or angular rotation at a given place on the structure to the loads and/or moments that might act at other parts of the structure. The flexibility influence coefficients, the reciprocity theorems and symmetrical properties of the deflection influence coefficient matrix, the stiffness influence coefficients, and the slop influence coefficients are defined analytically. Basically, the measurement of influence coefficients involves the application of known loads or moments at accurately determined points on a structure and the measurement of the resulting deformations of the structure. The experimental requirements for selection of influence stations, support systems, supports for heated structures, structural nonlinearity, least squares analysis, and use of reciprocity relations are discussed. Three methods of applying specified loads are considered: gravity loading, which is generally used for small components or models where the magnitude of the required forces is small; and hydraulic jacks and mechanical loading methods for cases requiring large loads. The advantages and disadvantages of devices for measuring the structural deformation due to linear deflection or angular deflection are discussed, and data readout and reduction methods are considered. The factors discussed may be used to select the optimum combination of mounting, loading, and deflection techniques for any specific configuration. M.P.G.

N63-17818 Calidyne Co., Winchester, Mass.

GROUND RESONANCE TESTING

R. C. Lewis and D. L. Wrisley (Wrisley Eng., Inc., Winchester, Mass.) *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Elasticity Part IV: Experimental Methods [1960] p 93–114 5 refs (See N63-17815 16-33)

Ground resonance testing methods, for distinguishing the many natural modes of vibration set up in aircraft and missile structures due to their distributed mass complexity, flexibility, and damping characteristics, are described. A knowledge of the dynamic behavior of these structures is necessary for the determination of flutter characteristics or of possible instability resulting from the coupling of a structural mode of vibration with the autopilot on missile control systems. The approaches to experimental determination of natural frequency, mode shape, and damping coefficient for each of several natural modes of the complex structure discussed include: (1) normal mode excitation by distributing forces in a manner intended to cancel the distributed structural damping forces, so that, by establishing pure normal modes without coupling, modes having frequencies fairly close together can be separated and defined; (2) experimental determination of quantities which decrease the effects of modal interaction followed by analytical separation of the modes of vibration using the experimental data; and (3) application of the admittance concept, in which a sinusoidal forcing function is applied to each of many points and the resulting complex response is measured at each of many points as a function of frequency. The resultant data are reduced to yield the admittance matrices from which normal, undamped frequencies and mode shapes may be calculated. The equipment used for resonance ground testing is described. M.P.G.

N63-17819 France. Office National d'Études et de Recherche Aéronautiques, Chatillon-sous-Bagneux

MEASUREMENT OF INERTIA AND STRUCTURAL DAMPING

H. Gauzy *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Elasticity. Part IV: Experimental Methods [1960] p 115–145 8 refs (See N63-17815 16-33)

Experimental methods of measuring inertia and structural damping and also of measuring generalized masses are presented. The structural damping methods discussed are strictly applicable only to a linear system with viscous damping and a single degree of freedom (called an elementary system). However, since some of the methods discussed are equally applicable to more general cases, the exact range of application of each method and the precise nature of what may be measured by the method are defined. The structural damping methods considered include the measurement of the damping coefficient frequency sweep, the measurement of the damping coefficient at resonance frequency from energy dissipation, and the measurement of the damping coefficient under transient conditions. The effect of dry friction is discussed. Methods for measuring generalized masses are also discussed. These include measurement by displacement of natural frequencies, and measurement from energy dissipation. M.P.G.

N63-17820 National Physical Lab., Teddington (Gt. Brit.)

WIND TUNNEL TECHNIQUES FOR THE MEASUREMENT OF OSCILLATORY DERIVATIVES

J. B. Bratt *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Elasticity. Part IV: Experimental Methods [1960] p 146–205 57 refs (See N63-17815 16-33)

The basic principles used in assessing the stability and flutter characteristics of aircraft and guided missile models in wind tunnels are discussed. The methods employed for the measurement of the aerodynamic derivatives fall into two main groups, depending on whether the aerodynamic reactions are deduced from the motion of the system resulting from some form of disturbance, or whether they are measured directly by means of force, moment, or pressure pickups. The first group may be further subdivided to distinguish between cases where the free motion is measured after removal of the disturbance, and cases where the excited motion is observed during the application of the disturbance. Some remarks on the techniques in general are presented, and individual techniques are discussed. Instrumentation for the measurement of displacement, force, pressure, amplitude, phase, and frequency is discussed in relation to its advantages and disadvantages for particular applications. The influence of the wind tunnel walls, fans, and injector slots on the measurements of damping and stiffness derivatives, as well as vortex wake disturbance and acoustic resonance effects are included. M.P.G.

N63-17821 National Physical Lab. Aerodynamics Div., Teddington (Gt. Brit.)

SIMILARITY REQUIREMENTS FOR FLUTTER MODEL TESTING

C. Scruton and N. C. Lambourne *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Elasticity. Part IV: Experimental Methods [1960] p 206–232 1 ref (See N63-17815 16-33)

The problem of simulating full-scale conditions with a model using a wind tunnel or some other means of testing involves: (1) construction of a model with the desired geometric similarity and stiffness and density distributions which, in combination with the available flow conditions, will adequately represent one or more specified flight conditions of the full-scale aircraft; and (2) determination of the scale factors which allow the flutter behavior of the full-scale aircraft to be deduced from measurements made with the model. Two systems are regarded as exhibiting similar flutter behavior when the mode of distortion during flutter is the same, the respective frequencies are related, and relationships exist between the respective flow conditions at the flutter boundaries. The similarity requirements are usually restricted to those just sufficient to provide adequate simulation in order to reduce the difficulties associated with model design and test conditions. The similarity laws and their applications are discussed for models in high-speed wind tunnels, and low-speed wind tunnels, sled-carried models and rocket-carried models, and for tests using aeroballistic ranges and models carried by a falling body. The advantages of testing in media heavier than air are considered, and the simulation of kinetic heating is included. M.P.G.

N63-17822 Dynamic Devices Inc., Dayton, Ohio

MODEL CONSTRUCTION

Lee S. Wasserman and Walter J. Mykytow (Aeronautical Systems Div. Flight Dynamics Div., Wright-Patterson AFB, Ohio) *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Elasticity. Part IV: Experimental Methods [1960] p 233–261 22 refs (See N63-17815 16-33)

The design and use of the flutter model for prediction of the flutter characteristics of full-scale aircraft is discussed. Electric analog techniques for flutter prediction use electronic components to simulate mass, elastic, and aerodynamic components. Flutter model techniques use a reduced scale physical analog whose results generally provide more accurate correlation with the full-scale aircraft. The history of the development of flutter models from 1940 on is presented, and the similarity rules are reviewed. The factors influencing the choice of the model scale are discussed. Geometrically, the scale is made small enough to reduce wind-tunnel wall effects and large enough to permit inclusion of sufficient detail to obtain reasonable flutter simulation. The speed ratio is selected on the basis of the true airspeed and sound speed in the facility. The density ratio is selected on the basis of the altitude which is expected to be the most critical from the flutter standpoint. The aspect ratio of the aircraft components also influences the choice of flutter model techniques; low-aspect-ratio flutter models involve simulation of chordwise and spanwise bending rigidity as well as torsional rigidity. The construction of low-speed and high-speed flutter models is discussed. Methods of supporting or suspending the model in the wind tunnel and of measuring the stiffness or deflection of the model are described. Instrumentation for vibrating the model and measuring the vibrational response is discussed. M.P.G.

N63-17823 Dynamic Devices, Inc., Dayton, Ohio

WIND TUNNEL FLUTTER TESTS

Lee S. Wasserman and Walter J. Mykytow (Aeronautical Systems Div. Flight Dynamics Div., Wright-Patterson AFB, Ohio) *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Elasticity. Part IV: Experimental Methods [1960] p 262–276 11 refs (See N63-17815 16-33)

The data which can be obtained from wind-tunnel testing of flutter models is reviewed together with the wind-tunnel techniques for obtaining this data. The data which may be obtained includes: flutter speed and Mach number, density or altitude effects, flutter frequency, basic modes involved in the flutter mode, response to simple harmonic or pulse excitation vs. airspeed, and overall stability level or damping vs. airspeed. In most cases it is sufficient to obtain only the density, velocity, Mach number, and flutter frequency. Techniques for obtaining these data involve various methods of exciting the model and measuring the response as a function of the wind-tunnel test conditions. The excitation may be provided by the wind-tunnel turbulence or by pulse type or sinusoidal type inputs; the response may be measured by strain gages or seismic pickups operating into standard recording oscillographs, oscilloscopes, and tape recorders. The operation of the wind tunnel during the test depends upon the number of variables, the type of tunnel, and the flutter boundary; procedures for transonic and supersonic blowdown, and continuous wind tunnels are discussed. Methods of preventing testing difficulties, such as model instability and structural failure, are presented, as well as methods of establishing a test program for a given model. The evaluation of the data obtained from wind-tunnel flutter-model tests is described, and model design techniques for minimizing wind-tunnel influence effects are discussed. Since the safety of flight personnel in the full-scale aircraft may depend upon the model flutter results, the inclusion of a margin of safety indication is recommended. M.P.G.

N63-17825 Royal Aircraft Establishment, Farnborough (Gt. Brit.)

FLIGHT FLUTTER TESTS

M. O. W. Wolfe and W. T. Kirkby *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Elasticity. Part IV: Experimental Methods [1960] p 293-322 18 refs (See N63-17815 16-33)

The basic objective of a flight flutter test is to determine the speed at which critical flutter would occur, and the type of flutter involved, from measurements made on the aircraft in flight at speeds safely below the critical speeds. This is accomplished by obtaining a measure of the damping ratios associated with the flight modes and their trends as the airspeed is progressively increased so that, from the damping trends at subcritical conditions, the approach of a critical condition may be indicated and its speed determined by extrapolation. Two continuously forced oscillation techniques which are currently used to analyze the response of the aircraft are described: (1) the amplitude response technique, which yields information on the stability trends of the flight modes of vibration as the airspeed or Mach number is increased but does not give an absolute measure of the damping ratios of the modes; and (2) the vectorial analysis technique, in which the stability trends are established from measurements of the absolute value of the damping ratios of the flight modes at each increment of speed. In addition, decaying oscillation techniques which are also used to investigate aircraft flutter characteristics are described. These techniques obtain information on the relative damping coefficients by exciting the relevant modes of the aircraft structure and allowing them to decay freely to rest; the damping ratios are deduced from the exponential decay rates. Methods of excitation for both continuously forced oscillation and decaying oscillation techniques are discussed, and instrumentation for measuring the aircraft response is described. The planning of the sequence of events in the flight flutter test is also discussed. M.P.G.

N63-17883 Armour Research Foundation, Chicago, Ill.

INVESTIGATION OF MATERIALS FOR MECHANICAL TRANSMISSION OF DEFLECTIONS AT ELEVATED TEMPERATURES [Final Report, June 15, 1961-July 30, 1962]

Joseph S. Islinger and Edward L. Mc Dowell May 1963 67 p 4 refs

(Contract AF 33(616)-8444)

(ASD-TDR-62-834)

Investigations were made of materials and methods for mechanically transmitting deflections from a structure under radiant heating to a transducer at room temperature. Transparent fused quartz rods were evaluated for expansion and thermal shock resistance. Rod growth was measured for such rods under several heating rates, with various exposed rod lengths, and at temperatures up to 2000° F. The growths enabled fairly accurate monitoring of static and cyclic displacements of a plate to which a transducer was connected through the quartz rod. High-purity recrystallized alumina rods were also evaluated for expansion and thermal shock resistance. Rod growth was also measured under several heating rates for a limited exposed length and at temperatures approaching 3000° F. The measured growths were considerably greater than those experienced by the quartz rods but not by a factor equivalent to the ratio of their thermal expansions. A successful means for attaching such rods to alumina structures capable of following static and cyclic displacements was developed. Author

N63-17915 Forest Products Lab., Madison, Wis.

DESIGN CURVES FOR THE BUCKLING OF SANDWICH CYLINDERS OF FINITE LENGTH UNDER UNIFORM EXTERNAL LATERAL PRESSURE [Progress Report]

Charles B. Norris and John J. Zahn May 1963 21 p 14 refs (Contract DO-33(616)61-06; BuWeps Order 19-61-8041-WEPS)

(FPL-07; FPL-1869, Rev.)

This report contains curves and formulas for the calculation of the critical external pressure of finite length, circular cylindrical shells with sandwich walls. The facings of the sandwich are equal and isotropic, and their individual stiffness is not taken into account. The sandwich core is isotropic or orthotropic, having natural axes in the axial, tangential, and radial directions of the cylinder. Curves are given for cylinders with sandwich walls having isotropic cores and orthotropic cores having certain relative elastic properties. If the cores are very rigid, the method yields results that are substantially those of von Mises. Author

N63-17948 General Electric Co. Research Lab., Schenectady, N.Y.

GENERAL THEORY OF BRITTLE FRACTURE

J. P. Berry Apr. 1963 44 p 32 refs

(Rept. 63-RL-(3284C))

The following aspects of the theory of brittle fracture have been reviewed. (1) The flaw hypotheses have been designed to account for the discrepancy between the theoretical and observed strengths of materials. Two different criteria have been suggested to define the condition of instability of a system, the first relating this condition to a limiting local stress, the second to the energy of the system. The relationship between these criteria is discussed. (2) The dynamic conditions which arise after the instability criterion is satisfied have received relatively little attention. It can be shown that such kinetic considerations provide insight into the nature of the instability criterion itself. (3) The models treated in the above theories usually assume that the flow is of zero thickness. This configuration gives rise to an infinite singularity in the stress field, and attempts have been made to avoid the anomalies that this entails by invoking the atomic nature of real materials, or assuming a local plastic or viscous response. Author

N63-18042 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPERIMENTAL INVESTIGATION OF FLUTTER OF BUCKLED CURVED PANELS HAVING LONGITUDINAL STRINGERS AT TRANSONIC AND SUPERSONIC SPEEDS

W. J. Tuovila and Robert W. Hess Washington, NASA, June 1959 21 p 6 refs

(NASA MEMO 5-18-59L) OTS: $2.60 ph, $0.83 mf

(Declassified)

Panel-flutter tests have been made at transonic and supersonic speeds, with particular reference to buckled curved panels with longitudinal stringers. Other panel configurations were also tested in an attempt to determine effects of skin thickness, curvature, stringers, buckling, pressure differential, and Mach number on the dynamic pressure necessary to start flutter. For buckled curved panels with longitudinal stringers, the dynamic pressure required to start flutter was increased by increasing the skin thickness, and increasing the pressure differential across the panel. There was no apparent effect of Mach-number variation from 1.3 to 2.0. None of the curved panels failed because of flutter, although the dynamic pressure at the start of flutter was exceeded by a factor of 3 in many cases. The flat panels fluttered at lower dynamic pressures than the curved panels, and four flat panels failed because of flutter. Author

N63-18054 Martin Co. Space Systems Div., Baltimore, Md.
A NUMERICAL STUDY OF THE RESPONSE CHARACTERISTICS OF COLUMNS SUBJECTED TO AXIAL LOAD PULSES Research Report
Norris J. Huffington, Jr. Aug. 1962 57 p 16 refs
(RR-31)

A previous report presented the analytical formulation for the dynamic buckling of columns, including the variation of axial load produced by longitudinal wave propagation. A method of solving the equations-of-motion, three coupled nonlinear partial differential equations, by the finite-difference procedure, was outlined. The present report discusses the stability criteria for finite difference solutions of these equations, and displays results of such calculations performed by an automatic computer. The importance of inclusion of the effects of rotary inertia and transverse shear deformation in the analysis is examined by contrasting solutions which do and do not include these effects. A study of the effects of varying load and structural parameters on the solution is also presented. Author

N63-18096 Grumman Aircraft Engineering Corp., Bethpage, N.Y.
HYDRODYNAMIC IMPACT LOADS ON BOWS FOR HYDROFOIL CRAFT. COMPARISON OF THEORY WITH MODEL TEST DATA. PART I—RAKED BOWS
J. H. Floyd and R. F. Mohrman Jan. 30, 1963 36 p 2 refs
(ADR-02-08-62.3)

A series of model tests was run for the purpose of checking the accuracy of the theoretical method of calculating bow impact loads. This report shows a comparison of the model test loads with the loads calculated by the theoretical method for the models having raked bows, under the test conditions of speed and wave height. The force and moment agreement is excellent. The dynamic portions of the theoretical method are not checked by the model tests, since the models were not free to pitch and heave. The models were designed to simulate a constant deadrise bow, with and without chines, and the bows of two designed boats at 1/32 scale. The wave heights and hull speeds were selected to simulate full-scale hull speeds up to 90 knots, in seas up to 32 feet. Author

N63-18138 General Electric Co. Advanced Engine and Tech. Dept., Cincinnati, Ohio
XV-5A LIFT FAN FLIGHT RESEARCH AIRCRAFT Quarterly Technical Progress Rept. No. 6, Mar. 15, 1963–June 15, 1963
June 30, 1963 77 p
(Contract DA-44-177-TC-715)

The Flightworthiness Penalty Test was successfully completed. Acceptance tests were completed on three lift fans, one pitch fan, and two diverter valves. Designed, manufactured, and tested was a "scupper" for the lift-fan rear frame to reduce fan damage from FOD. The propulsion-system Operating and Maintenance Instructions were issued. Aerodynamic data for hovering and transition six-degree-of-freedom simulation have been obtained. Fuel tanks successfully passed slosh and vibration tests. The canopy successfully tested to ultimate load. Author

N63-18142 Midwest Research Inst., Kansas City, Mo.
RESEARCH ON THE MECHANISMS OF FATIGUE IN ULTRA SMALL SPECIMENS Quarterly Progress Report 8, Mar. 1–June 1, 1963
J. C. Grosskreutz July 1963 12 p 2 refs
(Contract AF 33(616)-7858)

The effectiveness of wet anodic layers in suppressing near-surface dislocation motion was demonstrated. A new method of electrothinning has been worked out which keeps a known thickness of oxide in place on the surface of the sample at all times. Some difficulty still remains in achieving acceptable films for microscopy. The propagation of fatigue cracks along subgrain boundaries in pure aluminum has been demonstrated. The existence of subgrains at the tip of fatigue cracks in 2024 and 7075 aluminum alloys has also been shown. The size of the plastic zone decreases with increasing alloy content. A discussion is given of the energy balance required in the propagation of fatigue cracks in aluminum, and the influence of subgrains on this propagation. Author

N63-18158 Wyle Labs, Inc., El Segundo, Calif.
VIBRATION AND SHOCK TESTING ON PROTOTYPE HORIZON SENSOR FOR SPACO, INC. Test Report
John R. Herring July 5, 1962 32 p 2 refs
(NASA Contract NAS8-2651)
(NASA CR-50482; Rept. 12632) OTS: **$3.60 ph, $1.16 mf**

A prototype horizon sensor mounting and dome was subjected to a vibration and shock test program as described. During the course of the vibration test, a number of rivets were sheared off due to motion of the specimen. Also, the dome was observed to rotate on its mountings. At the completion of the vibration test program, the explosive charge shear pins were found to be broken. There was no evidence of damage as a result of the shock test. Author

N63-18176 National Bureau of Standards, Washington, D.C.
A SIMPLE ENVIRONMENTAL CHAMBER FOR ROTATING-BEAM FATIGUE TESTING MACHINES
J. A. Bennett Repr. from Materials Res. and Standards, v. 3, June 1963 p 480–483 4 refs
(NASA Order R-14)
(NASA CR-50407)

A gas-tight sleeve of polyethylene film is described which permits fatigue testing of metals and alloys in a controlled atmosphere. Tests of magnesium and aluminum alloys in this sleeve have shown that changes in humidity may change the fatigue strength by more than 10 percent. It can be concluded from these tests that dispersion in fatigue test results can be reduced. Also, it is believed that the sleeve may be useful for investigating the effect of gaseous atmospheres other than air on the fatigue strength of materials. I.v.L.

N63-18179 Rice U., Houston, Tex.
A DISCUSSION OF THE IMPORTANCE OF LINE TENSION ON COTTRELL'S THEORY OF THE SHARP YIELD POINT
D. M. Barnett and J. M. Roberts Repr. from Trans. Met. Soc. of AIME, v. 227, June 1963 p 658–664 16 refs
(NASA Grant NsG-6-59)
(NASA CR-50498)

The activation energy required to break a pinned dislocation line away from its condensed atmosphere of impurity atoms is calculated as a function of applied stress, without neglecting line tension. The dislocation is considered to be pinned at each atomic site along its length, and the pinning points are assumed immobile. The development is a refinement of the original Cottrell–Bilby theory. A qualitative explanation of the yielding process in terms of the activation of Frank–Read sources is presented, but the lack of a realistic solution to the dynamic dislocation problem involved prevents an extension of the model at present. A self-consistent correlation between the present calculations and experimental data for delay time, associated with yielding, and the temperature dependence of the upper yield stress was made. Favorable agreement was noted. It is concluded that extension of the original Cottrell–Bilby theory, which includes line tension effects, can as well describe the yielding process as other approximations which neglect line tension. Author

N63-18182 Space Technology Labs., Inc., Redondo Beach, Calif.
ON THE EXPERIMENTAL DETERMINATION OF THE COMPLEX SHEAR MODULES OF A LINEAR, ISOTROPIC VISCOELASTIC SOLID
W. G. Gottenberg and R. M. Christensen June 1, 1963 32 p 11 refs
(Rept. 6121-6777-RUOOO; EM-13-14)

Of the several theoretically equivalent means of representing the stress-strain behavior of a linear viscoelastic solid, it is shown that the manner of description afforded by the complex modulus function is the most desirable from the standpoint of experimentally determining the mechanical characteristics of such a solid. This described experiment involves the forced torsional oscillations of a right circular cylinder whose ends are bonded to rigid boundaries. Following a discussion of the analysis for the particular test conditions used and a description of the experimental techniques employed, measured values of the complex shear modulus are given for a typical polymeric material over a range of frequencies and temperatures. Author

N63-18202 Illinois Inst. of Tech., Chicago
THE DYNAMIC VISCOPLASTIC EXPANSION OF A CYLINDRICAL TUBE
Edmund J. Appleby May 1963 26 p 6 refs
(Contract Nonr-140604)
(DOMIIT-1-24)

The viscoplastic flow of a long thick-walled tube is investigated. The tube is subjected to internal pressure, and has its ends restrained from motion in the axial direction. The material of the tube is rigid-viscoplastic and incompressible. The pressure required to produce a specified expansion of the tube is calculated for two examples. In the former, the effect of different viscosity coefficients is observed. In the latter example, a comparison is made of the effects of perfect plasticity, viscosity, and inertia. Author

N63-18211 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LOADS INDUCED ON A FLAT PLATE AT A MACH NUMBER OF 4.5 WITH A SONIC OR SUPERSONIC JET EXHAUSTING NORMAL TO THE SURFACE
William Letko Washington, NASA, July 1963 25 p 8 refs
(NASA TN D-1935) OTS: $0.75

An investigation was made to determine the pressure distributions on a flat plate with a sonic or a supersonic jet exhausting normal to the plate surface. Tests were made at a Mach number of 4.5 for a range of jet pressure ratios (that is, ratio of stagnation pressure of secondary jet to free-stream static pressure), and for various free-stream Reynolds numbers. Based on a comparison of the ratio of the total reaction force of the test jet to the calculated reaction force of an isolated fully expanded jet (with mass flow equal to that of the test jet), the supersonic nozzle appears to be more effective for use as a control than the sonic nozzle. Total force as used herein is the calculated simple reaction force of an isolated nozzle, plus the induced force resulting from the secondary-jet interference with the stream flowing over the flat plate. The data also indicate that eliminating areas of negative pressure on the plate would cause an increase in effectiveness up to approximately 12 percent for either jet. Author

34 STRUCTURAL DESIGN

Includes: structural elements; and weight analysis.

***For related information see:* 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 33 Stresses and Loads.**

N63-17606 Beechcraft Research and Development, Inc., Boulder, Colo.
ESTABLISHING TANK DESIGN CRITERIA FOR LIQUID HYDROGEN ROCKETS. VOLUME IV– FLIGHT SIMULATION TEST PROGRAM Final Report [July 1958]-31 Jan. 1962
H. L. Breckenridge and D. A. Van Gundy Edwards AFB, Calif., Air Force Flight Test Center, June 1963 161 p
(Contract AF 33 (616)-5154, Suppl. S3(59-207))
(AFFTC-TR-60-43, Vol. IV)

This flight simulation test program is directed toward the solution of the basic heat transfer problem in a hydrogen fuel tank during powered flight. A 7,000-gallon liquid-hydrogen tank was fabricated from both stainless steel and titanium. Fabrication methods as well as thermal and hydrostatic testing of these tanks are discussed. I.v.L.

N63-17657 Astro Research Corp., Santa Barbara, Calif.
ANALYTICAL DESIGN FOR OPTIMUM FILAMENTARY PRESSURE VESSELS
Hans Schuerch New York, American Inst. of Aeron. and Astronautics, Apr. 1963 26 p 10 refs Presented at the AIAA Launch and Space Vehicle Shell Structures Conf., Palm Springs, Calif. Apr. 1–3, 1963
(AIAA Paper 2914-63) AIAA: $0.50 members, $1.00 non-members

The effects of centrifugal loading on filament-wound pressurized structures are analyzed. The analysis is an extension of the basic equilibrium conditions developed by Schuerch, Burggraf, and Kyser (Sept. 1961): the results are given in the form of analytic expressions involving tabulated functions. The basic differential equations for equilibrium conditions, filament orientation, and filament geometry are discussed and integrated, and an expression for filament length is derived. The possible meridional shapes (hyperboloid, cylinder, cusp, toroid, and asymptotic loop) are discussed in terms of three characteristic parameters K (pressure load intensity), Ω (centrifugal load intensity), and C (angularity of the winding pattern). Two types of experiments were conducted to test the predicted equilibrium shapes of rotationally symmetrical filamentary structures: (1) A series of toroidal filament-wound pressure vessels were made, the shell geometry was stabilized, the equilibrium contour was recorded and compared to the analytically predicted shapes, and then the internal pressure was raised to the burst point to observe the failure mechanism. (2) A single, heavy filament in the form of a link chain was subjected to centrifugal forces to determine its geometrical arrangement for comparison with the analytically derived data. Generally good agreement with theory was obtained in both series of experiments. Possible applications for the analytical techniques presented are discussed. M.P.G.

N63-17670 Aeronautical Systems Div. Flight Dynamics Lab., Wright-Patterson AFB, Ohio
POWER SPECTRAL DENSITY TECHNIQUES APPLICABLE FOR STRUCTURAL DESIGN CRITERIA AND ANALYSIS. STATE-OF-THE-ART-REPORT [Technical Report, Feb. 1961 through Dec. 1961]
Leon J. Bowser May 1962 60 p 46 refs
(ASRMDS-TM-62-4)

A review and analysis of the status of the state-of-the-art regarding application of power-spectral-density techniques to structural-design criteria are presented. In addition, the report includes a detailed account of some experience in applying these techniques, and a brief introduction to spectral-analysis techniques. Author

N63-18907 Grumman Aircraft Engineering Corp., Bethpage, N.Y.

FLEXIBLE WHEEL PARAMETRIC DESIGN CURVES

Ivan Villalba and Wing Lee Feb. 1963 40 p 33 refs
(ADR-04-05-62.1)

Parametric design curves for a flexible wheel were developed from the solution of the problem of a ring supported by an elastic foundation under a concentrated radial load. In reality, the wheel has individual flexible spokes, and the approximation of an elastic foundation seems to yield reasonably good results for design purposes. Author

N63-18123 Lockheed Missiles and Space Co., Sunnyvale, Calif.

ALL-METAL SANDWICHES EXCEPT HONEYCOMB-CORE: AN ANNOTATED BIBLIOGRAPHY [Jan. 1956-Jan. 1962]

Eugene E. Graziano, comp. Mar. 1962 81 p 189 refs
(Contract AF 647/787)
(SB-62-8)

The purpose of this search was to discover existing literature relating to all-metal sandwiches, except honeycomb-core, published from 1 January 1956 to January 1962, that might be of interest in space vehicle and missile applications. Author

N63-18195 National Bureau of Standards, Washington, D.C.

STRUCTURE SHIELDING AGAINST FALLOUT RADIATION FROM NUCLEAR WEAPONS

L. V. Spencer June 1, 1962 133 p 41 refs
(NBS-Monograph-42) GPO: $0.75

The theory of structure shielding from fallout gamma radiation is developed to the point of applications to elementary structure types. Examples discussed include the density interface, foxhole, shielded foxhole or basement, light superstructure, vertical wall, blockhouse, vents, compartmentalization effects, and mazes. A large number of engineering charts and graphs are presented for engineering calculations, including many obtained from angular distributions of the exposure dose. Results are given for a fission spectrum, and for Co^{60} and Cs^{137} sources. This information has been obtained almost completely by machine calculations utilizing basic cross-section data. A number of sources of experimental data are mentioned. Author

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